BLM LIBRARY
88041582

DRAFT

APPENDIX B
-Map Foldouts-

APPENDIX C
-Glossary & Bibliography-

APPENDIX D
-Other Support Material-

ENVIRONMENTAL IMPACT STATEMENT

NORTHWEST COLORADO COAL

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

2428838

ID88041582

TD
195
.C58
N67
1976
v.7

APPENDIX B

Table of Contents

Maps

Map Foldout #1 Northwest Colorado oil and gas fields and coal bearing regions and fields.

Map Foldout #2 Locations of the coal leases and coal lease applications within the Northwest Colorado coal region.

Map Foldout #3 Locations of proposed actions.

Map Foldout #4 Folds and faults of northwestern Colorado.

Map Foldout #5 Other selected minerals in Northwest Colorado.

Map Foldout #6 Ground water availability.

Map Foldout #7 Major water drainages. Routt, Moffat and parts of Rio Blanco Counties. (color)

Map Foldout #8 General soil map of Routt, Moffat and parts of Rio Blanco Counties. (color)

Map Foldout #9 Vegetative types, Moffat and parts of Routt and Rio Blanco Counties. (color)

Map Foldout #10 Major Stream Fisheries. (color)

Map Foldout #11 Locations of surface water gaging stations.

Map Foldout #12 Existing Recreation. (color)

Map Foldout #13 Recreation resources within the Northwest Colorado coal region.

Map Foldout #14 Archeological and historical resources.

Map Foldout #15 Pronghorn and elk distribution and season of use within the Northwest Colorado coal region.

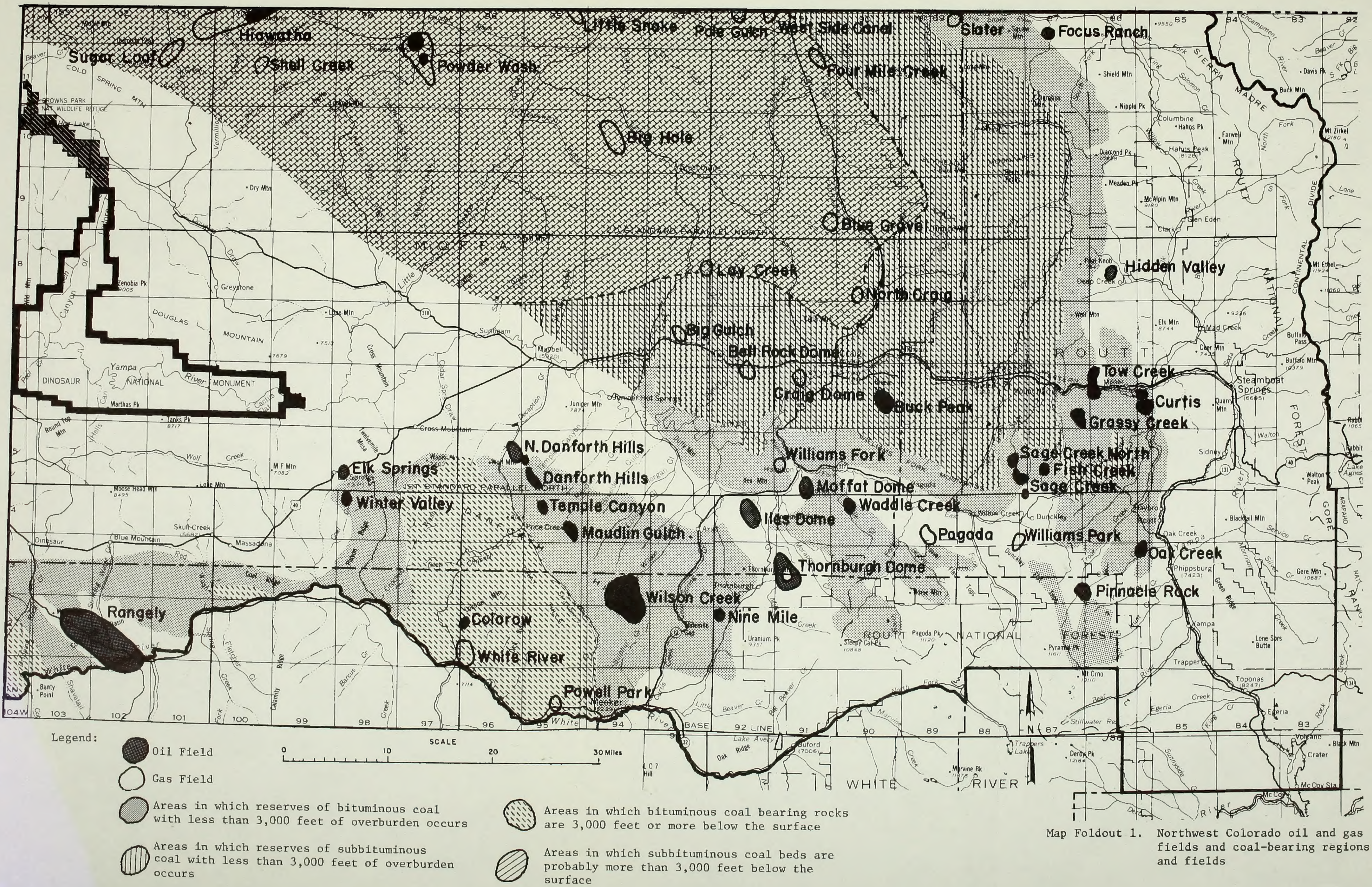
Map Foldout #16 Season of use and class of livestock within the Northwest Colorado coal region.

Map Foldout #17 Season of use for mule deer within the Northwest Colorado coal region.

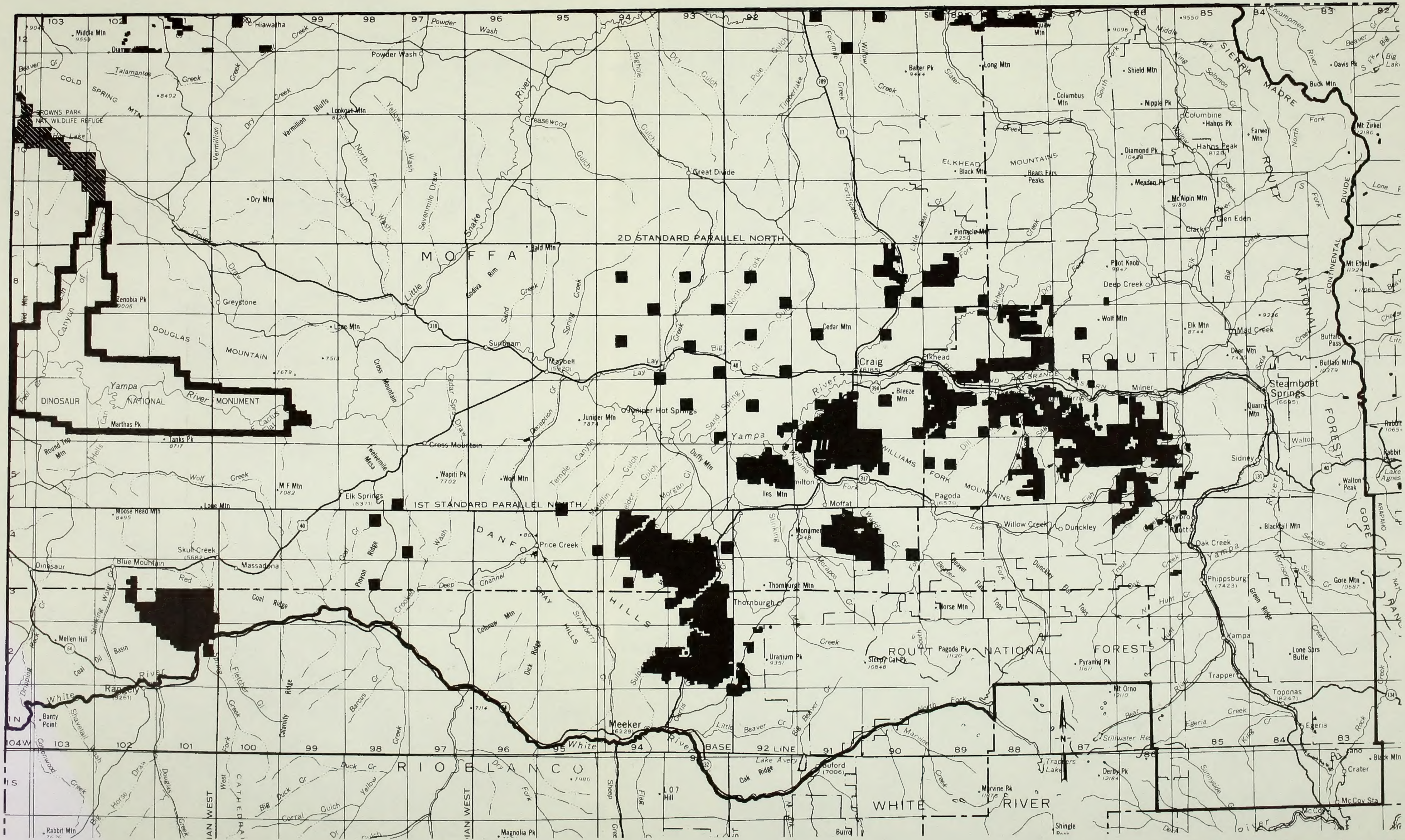
Map Foldout #18 Distribution of some important wildlife species within the Northwest Colorado coal region.

BLM LIBRARY
SC-653, BLDG. 50
DENVER FEDERAL CENTER
P.O. BOX 25047
DENVER, CO 80225-0047

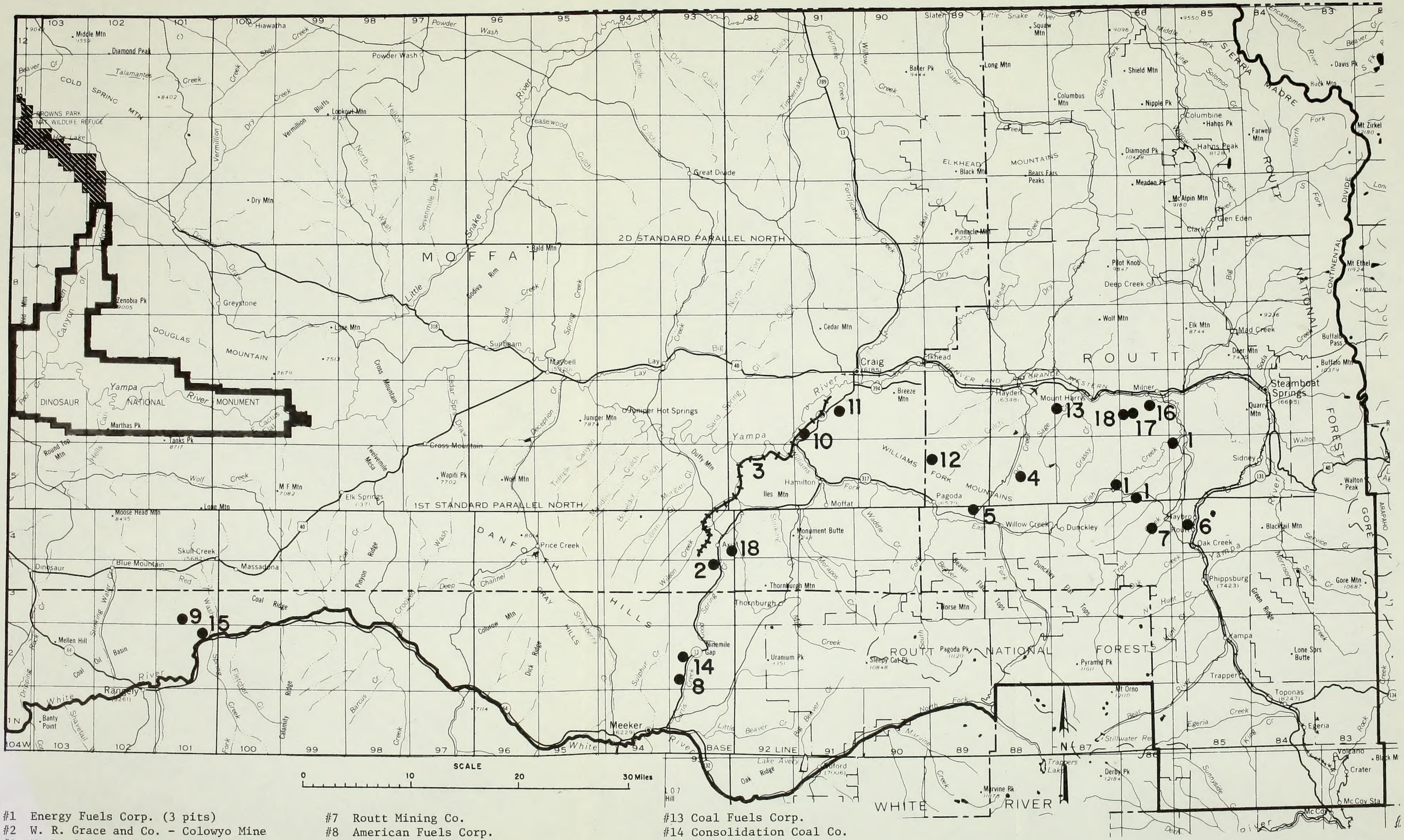
This book is the property of the United States Government. It is [illegible] your custody by your employing agency. You may [illegible] reference as the needs of the agency may require. When [illegible] this purpose or when you leave your agency, it should [illegible] to an appropriate official of your agency.



Map Foldout 1. Northwest Colorado oil and gas fields and coal-bearing regions and fields

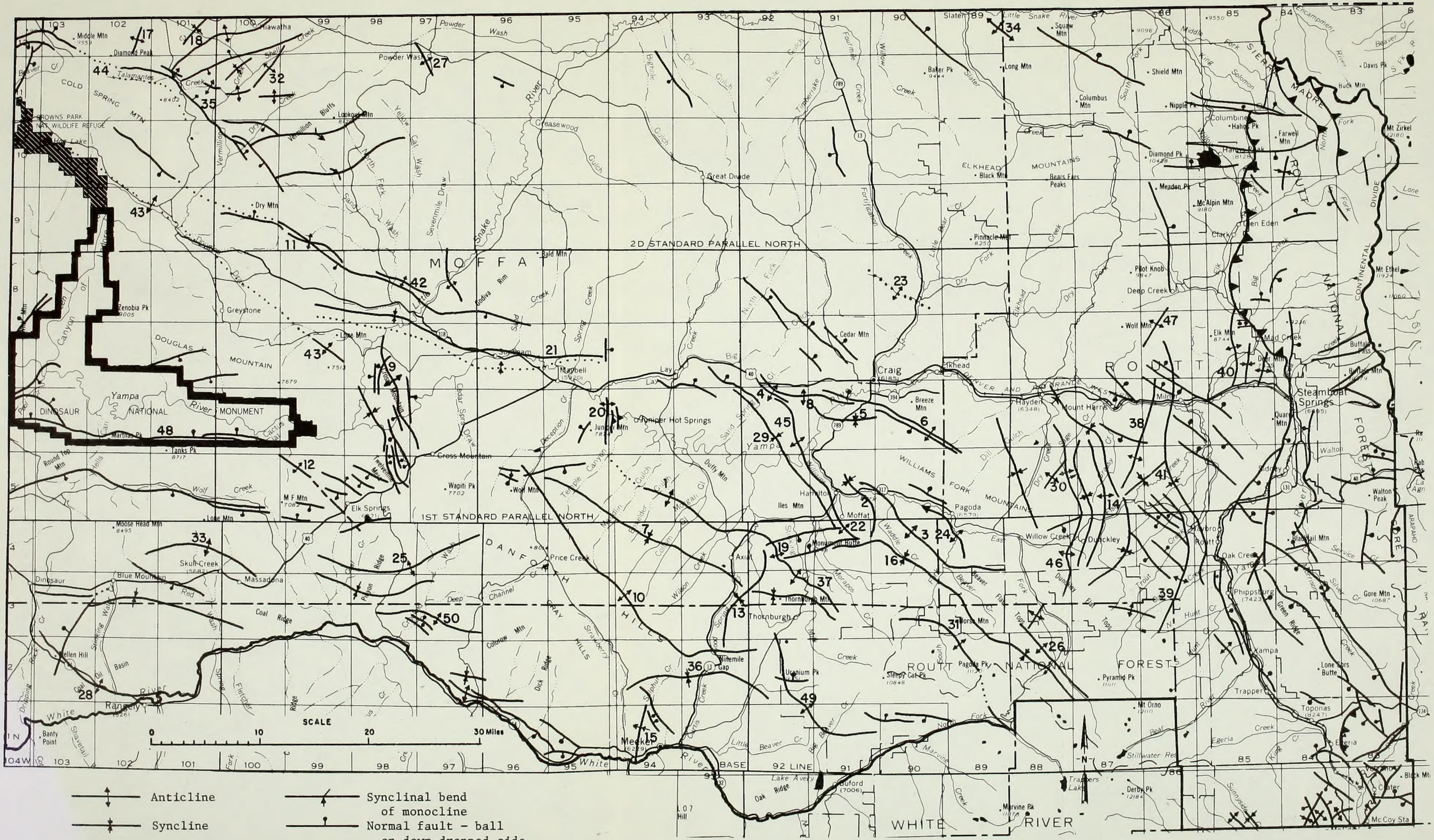


Map Foldout 2. Locations of coal leases and coal lease applications within the Northwest Colorado coal region.



#1 Energy Fuels Corp. (3 pits)
#2 W. R. Grace and Co. - Colowyo Mine
#3 W. R. Grace and Co. - Railroad
#4 Peabody Coal Co.
#5 Ruby Construction Co.
#6 Pittsburg and Midway Coal Mining Co.
#7 Routt Mining Co.
#8 American Fuels Corp.
#9 Moon Lake Electric Asso.
#10 Empire Energy Corp.
#11 Colorado Ute Electric Association
#12 American Electric Power Service Corp.
#13 Coal Fuels Corp.
#14 Consolidation Coal Co.
#15 Midland Coal Co.
#16 Merchants Petroleum Co.
#17 Thomas C. Woodward
#18 Paul S. Coupey (2 sites)

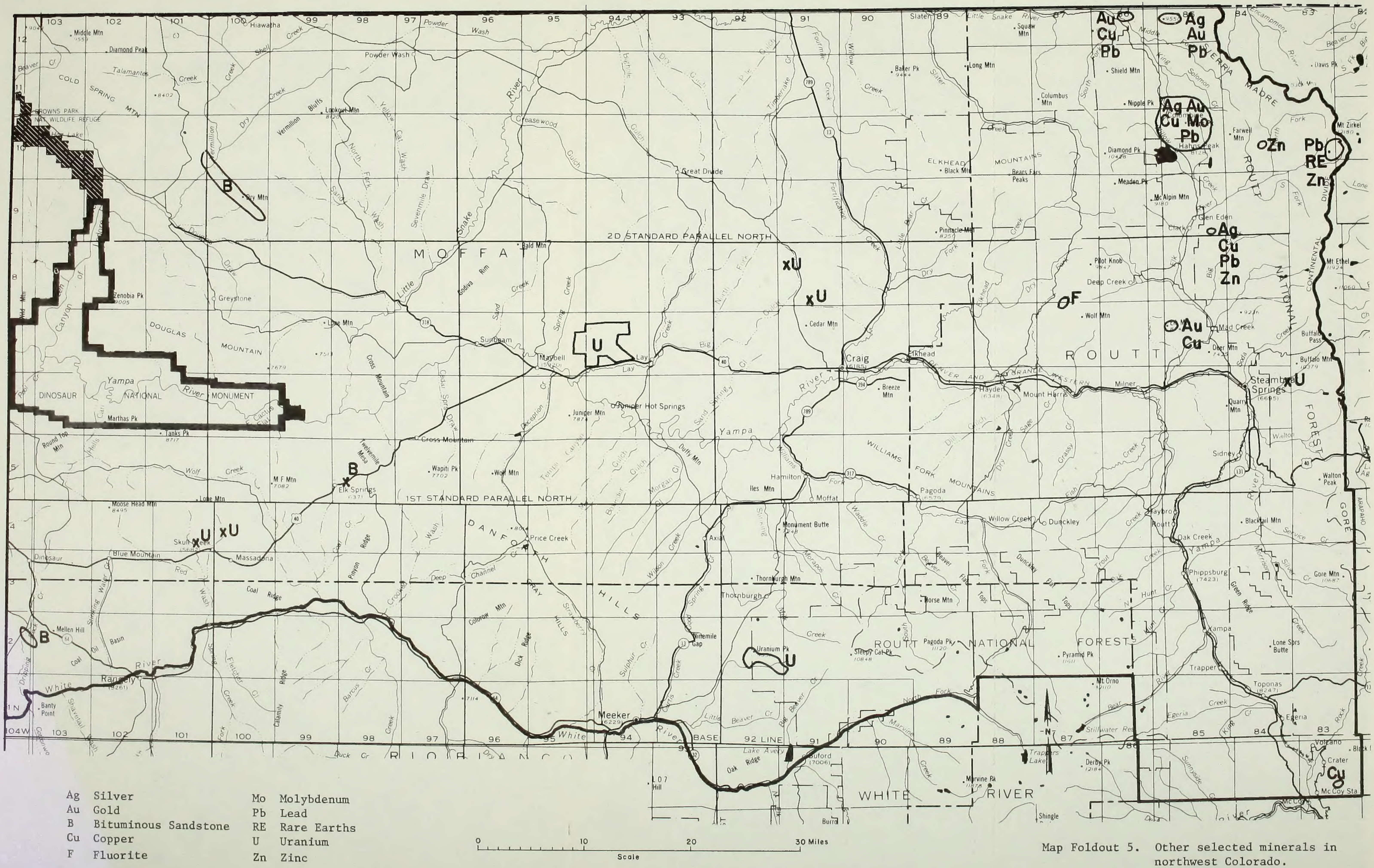
Map Foldout 3. Locations of proposed actions



- Anticline
- Syncline
- Monocline
- Anticlinal bend of monocline
- Synclinal bend of monocline
- Normal fault - ball on down-dropped side
- Thrust fault - sawteeth on overthrust side
- Structures buried or uncertain

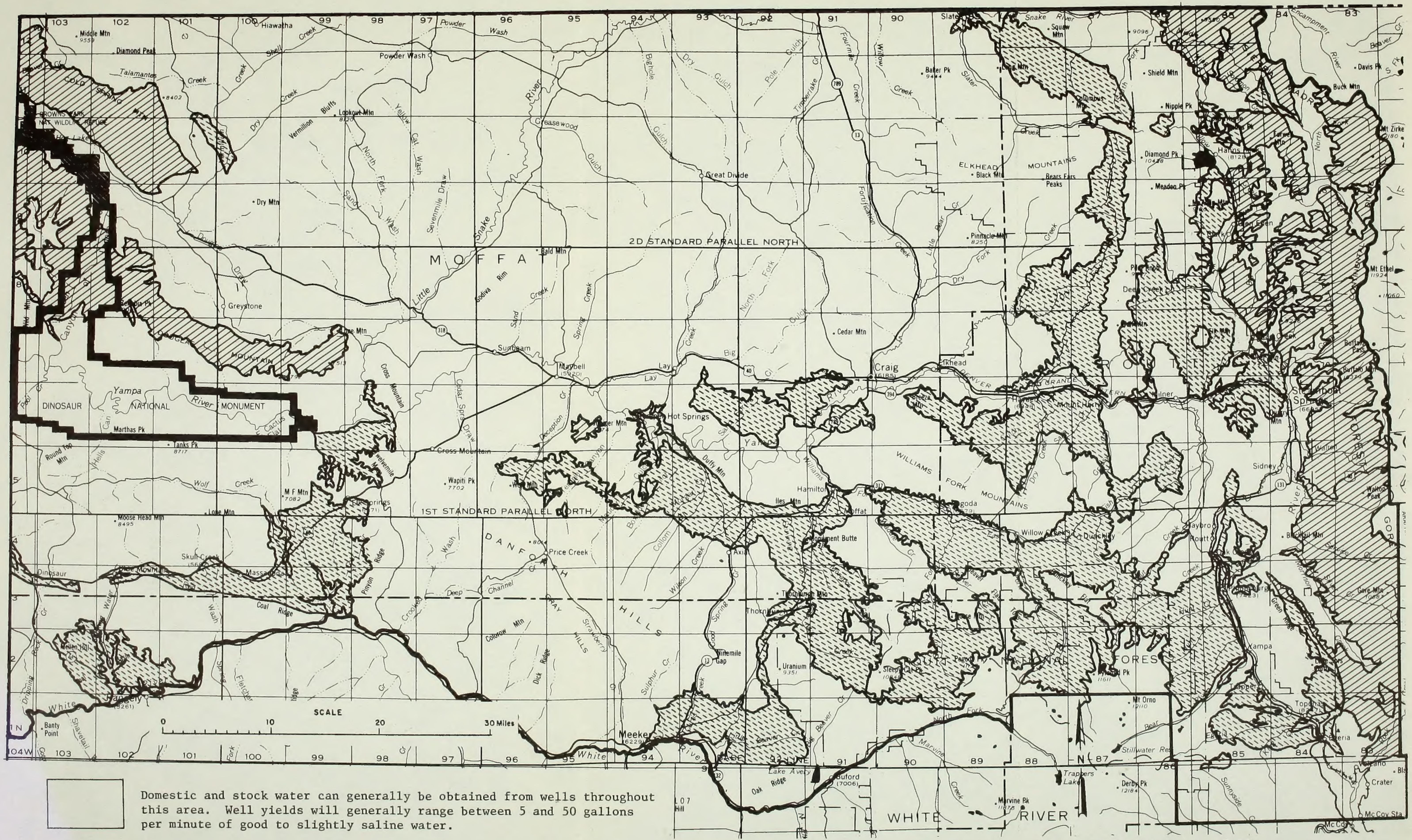
SOURCES: U.S.G.S. maps MF 130 and MF 666
Editorial staff, IAPG-RMAG Guidebook, August 1955

Map Foldout 4. Folds and faults of northwestern Colorado



Ag	Silver
Au	Gold
B	Bituminous Sandstone
Cu	Copper
F	Fluorite
Mo	Molybdenum
Pb	Lead
RE	Rare Earths
U	Uranium
Zn	Zinc

Map Foldout 5. Other selected minerals in northwest Colorado.

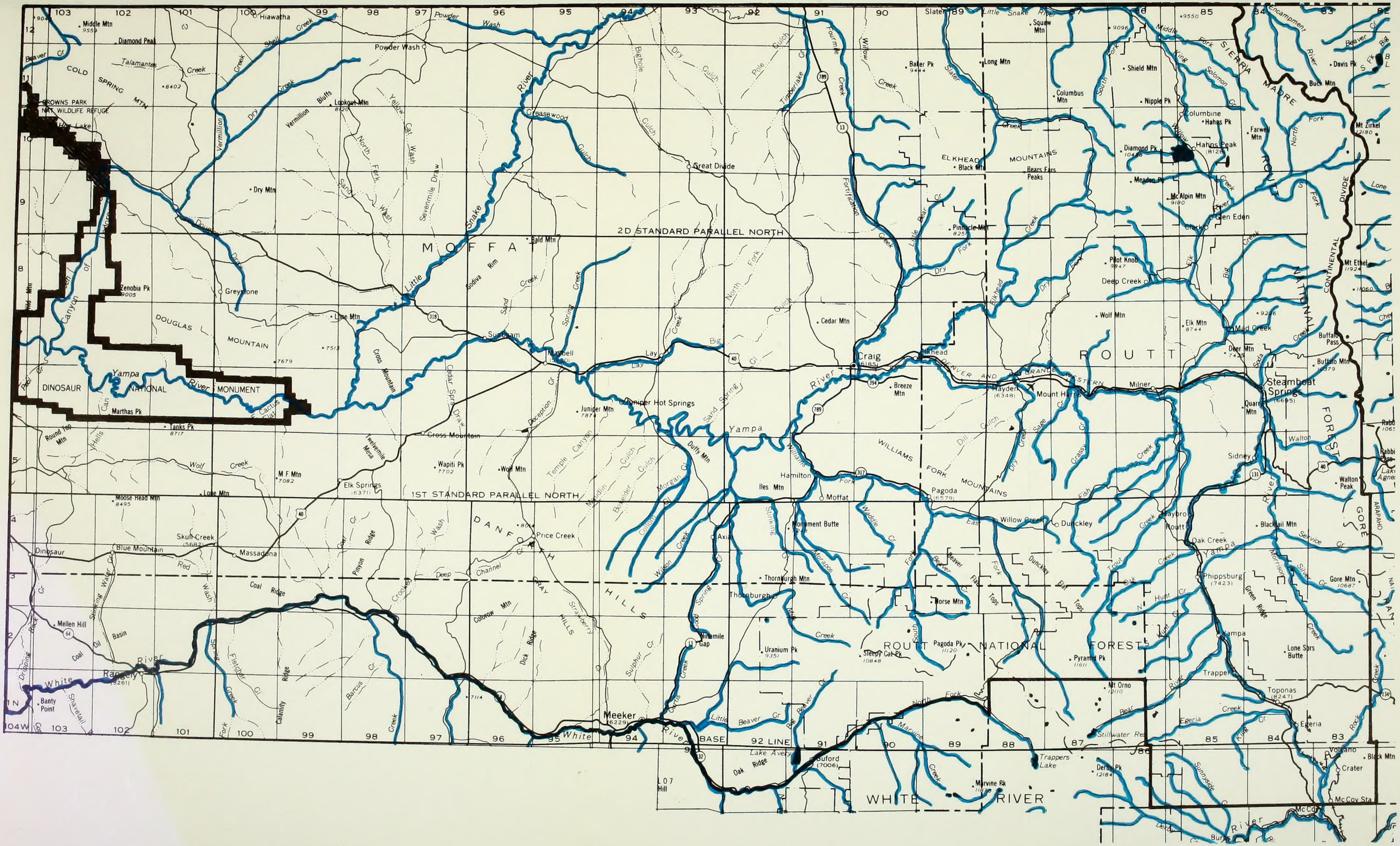


☐ Domestic and stock water can generally be obtained from wells throughout this area. Well yields will generally range between 5 and 50 gallons per minute of good to slightly saline water.

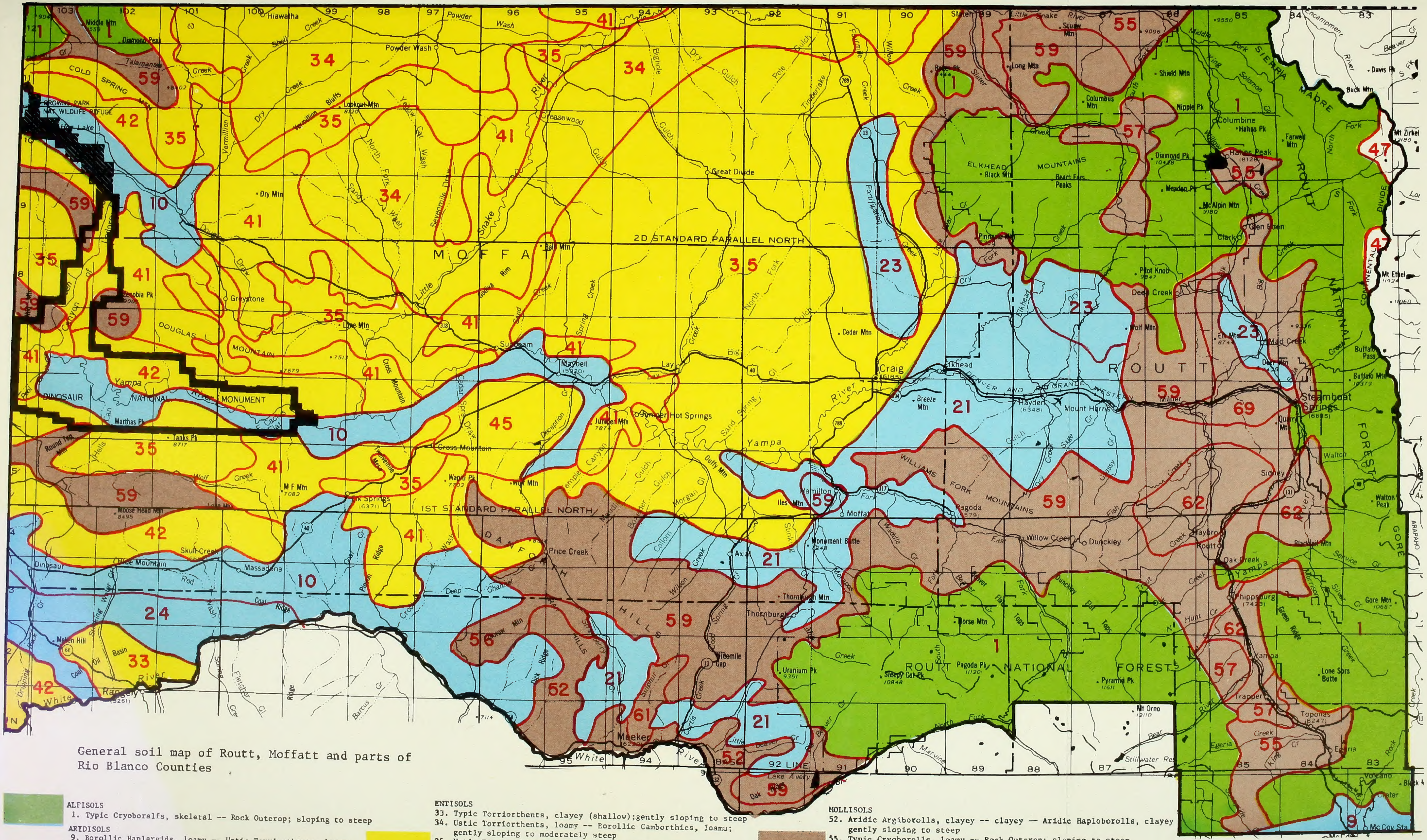
▨ Domestic and stock water can be obtained locally from fracture zones in these rocks. Well yields will generally range between 2 and 20 gallons per minute of good quality water.

▧ This area is underlain by poorly permeable saline shales up to 5,000 feet thick. Useable water is available locally at shallow depths, however wells will generally need to penetrate these shale formation in order to obtain useable water.

Map Foldout 6. Ground water availability



Foldout 7. Major water drainages of Routt, Moffatt and parts of Rio Blanco Counties



General soil map of Routt, Moffatt and parts of Rio Blanco Counties

🟩 ALFISOLS
1. Typic Cryoboralfs, skeletal -- Rock Outcrop; sloping to steep

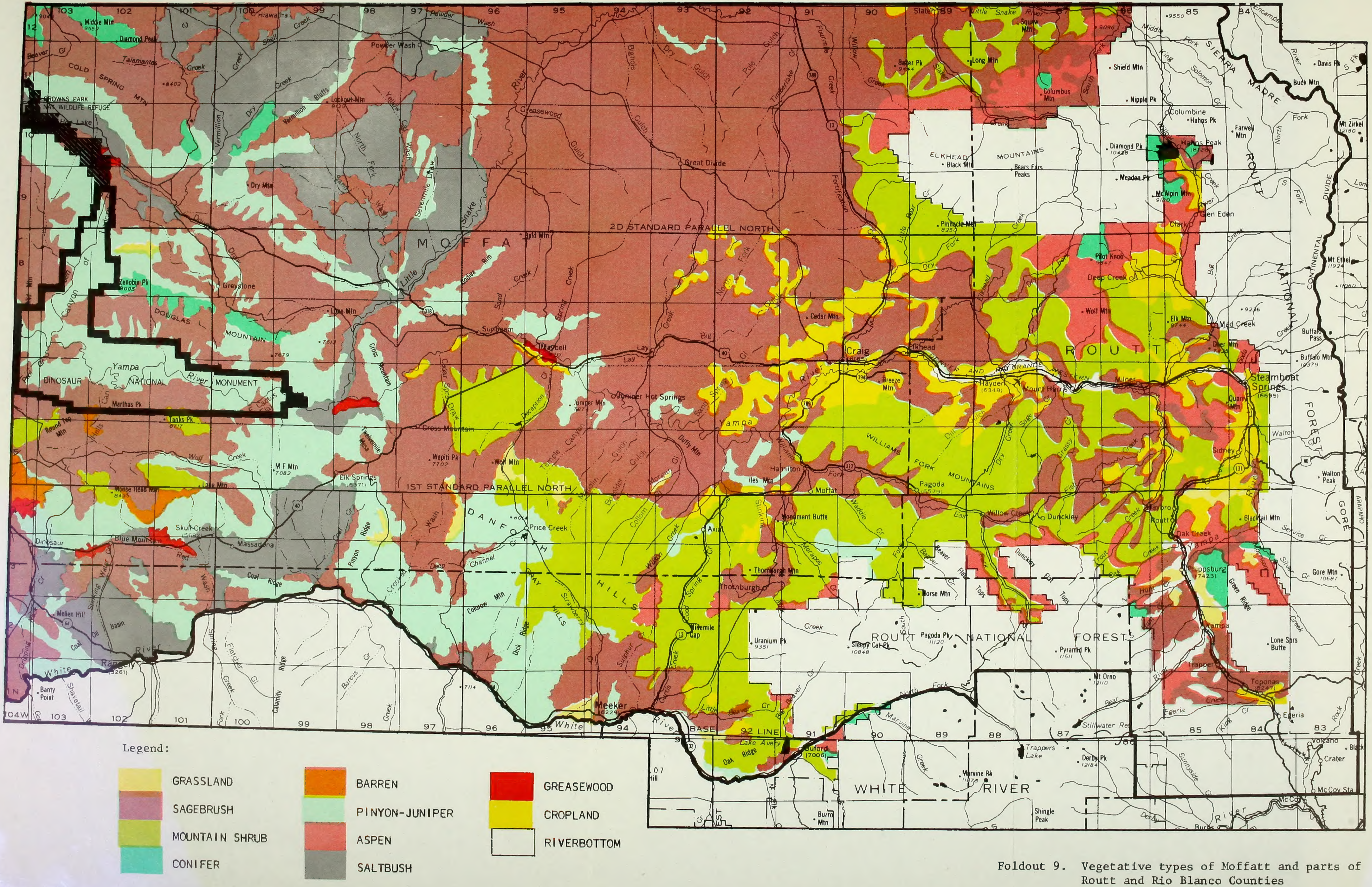
🟦 ARIDISOLS
9. Borollic Haplargids, loamy -- Ustic Torriorthents, loamy; nearly level to moderately steep
10. Ustollic Haplargids, loamy; nearly level to gently sloping
21. Borollic Camborthids, clayey -- Aridic Argiborolls, loamy; gently sloping to moderately steep
23. Borollic Vertic Camborthids, clayey; gently sloping to moderately steep
24. Lithic Camborthids, loamy -- Lithic Ustic Torriorthents, loamy; steep

🟨 ENTISOLS
33. Typic Torriorthents, clayey (shallow);gently sloping to steep
34. Ustic Torriorthents, loamy -- Borollic Camborthics, loamu; gently sloping to moderately steep
35. Ustic Torriorthents, loamy-- Aridic Argiborolls, loamy; nearly level and gently sloping
41. Lithic Ustic Torriorthents, loamy -- Ustic Torriorthents, loamy; sloping to steep
42. Lithic Ustic Torriorthents, loamy -- Rock outcrop; gently sloping to steep
45. Ustic Torripsaments, gently sloping to steep

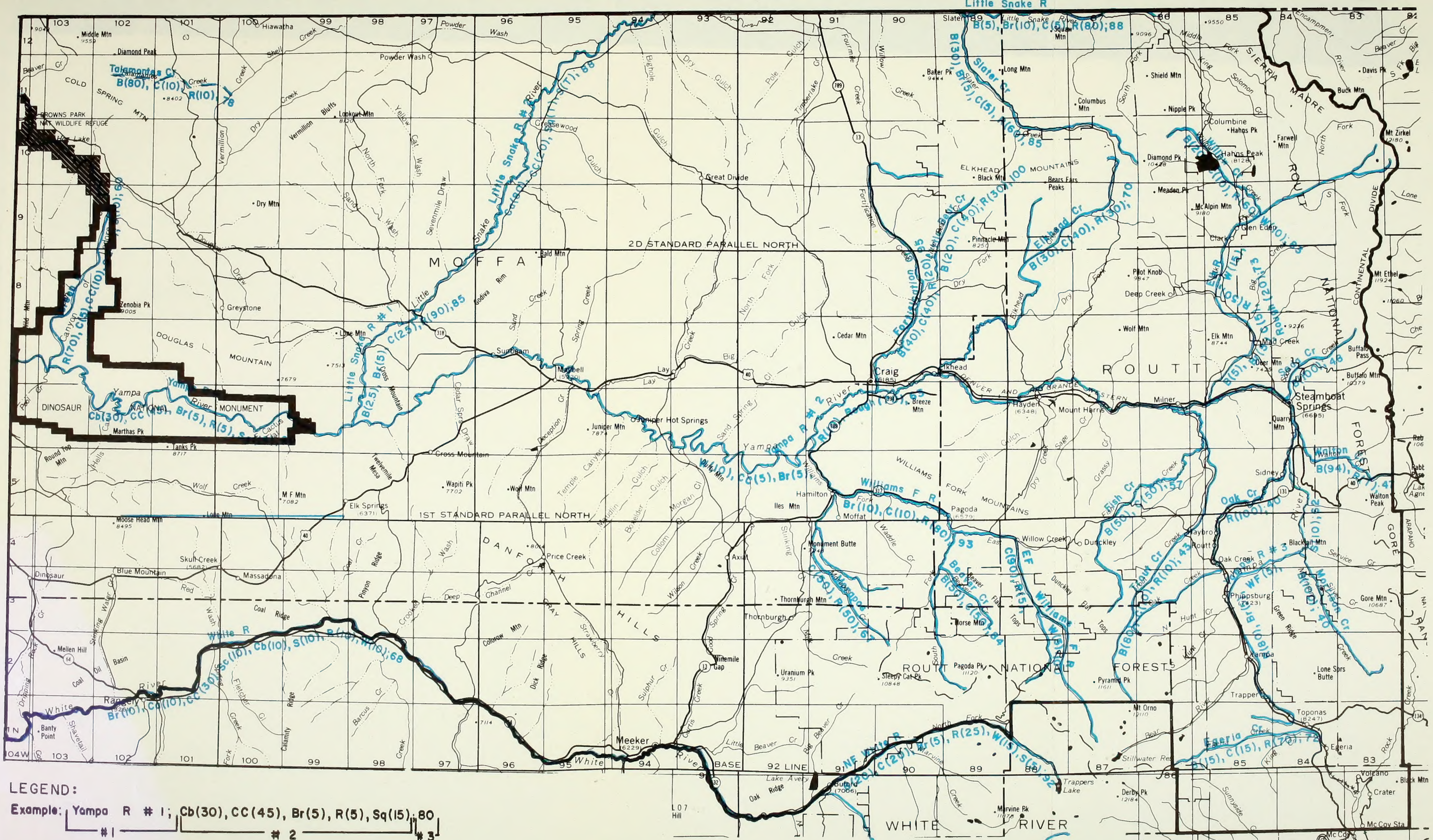
⬜ INCEPTISOLS
47. Pergelic Cryumbrepts, skeletal -- Pergelic Cryochrepts skeletal --Rock Outcrop; sloping to steep

🟫 MOLLISOLS
52. Aridic Argiborolls, clayey -- clayey -- Aridic Haploborolls, clayey gently sloping to steep
55. Typic Cryoborolls, loamy -- Rock Outcrop; sloping to steep
56. Typic Cryoborolls, clayey -- Typic Cryoboralfs, skeletal; moderately steep and steep
57. Typic Cryoborolls, clayey -- Typic Cryorthents, clayey sloping to steep
59. Argic Cryoborolls, loamy -- Cryic Paleoborolls, loamy; nearly level to moderately steep
61. Lithic Haploborolls, skeletal -- Rock outcrop; moderately steep and steep
62. Typic Paleborolls, clayey -- Borollic Camborthids, clayey gently sloping to moderately steep

Foldout 8.



Foldout 9. Vegetative types of Moffatt and parts of Routt and Rio Blanco Counties


Little Snake R
Slater Cr B(5), Br(10), C(5), R(80); 88
Slater Cr B(30), Br(5), C(5), R(60); 85
Talamantes Cr B(80), C(10), R(10); 78
Little Snake R # 2 Cb(80), CC(20), S(T); 88
Little Snake R # 1 C(2.5), R(90); 85
Little Snake R B(2.5), Br(5)
Green R Canyon of Lodore R(70), C(5), CC(10); 60
Yampa R # 1 Cb(30), CC(45), Br(5), R(5), S
Elkhead Cr B(30), C(40), R(30); 70
B(20), C(40); R(30); 100
Fortification Cr B(40), C(40), R(20); 65
Yampa R # 2 R(10), Rough; 65
W(10), CC(5), Br(5)
Williams F R Br(10), C(10), R(80); 93
EF Williams F R C(90), R(5)
Beaver Cr B(50), C(50); 84
Milk Cr C(50), R(50); 67
Willow Cr B(20), C(10), R(60), W(10); 83
Elk R W(15), R(50)
Big Cr C(5), Rough(20); 73
Soda Cr B(100); 48
Elk R B(5)
Fish Cr B(50), C(50); 57
Oak Cr R(100); 40
Walton Cr B(94), R; 47
Trout Cr B(80), R(10); 43
Yampa R # 3 WF(5), Br(10), R(80)
Morrison Cr B(100); 40
Yampa R S(10); 52
Egeria Cr B(15), C(15), R(70); 72
NF White R B(20), C(20), Br(5), R(25), W(15), S(5); 92
White R Sc(10), Cb(10), S(10), R(10), W(10); 68
Br(10), Ca(10), CC(30)
SF White R
MOFFAT
ROUTT
ROUTT NATIONAL FOREST
WHITE RIVER
DINOSAUR NATIONAL MONUMENT
2D STANDARD PARALLEL NORTH
1ST STANDARD PARALLEL NORTH
BASE 92 LINE
CONTINENTAL DIVIDE
SIERRA MADRE
ELKHEAD MOUNTAINS
WILLIAMS FORK MOUNTAINS
DANFORTH HILLS
GRAY HILLS
DOUGLAS MOUNTAIN
COLD SPRING MTN
BROWNS PARK NAT WILDLIFE REFUGE
Craig
Steamboat Springs
Meeker
Rangely
Hayden
Maybell
Yampa
Dinosaur
Oak Creek
Phippsburg
Trappers Lake
103
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83

LEGEND:

Example: Yampa R # 1; Cb(30), CC(45), Br(5), R(5), Sq(15); 80
#1 #2 #3

Position: # 1 Stream Name - Yampa R # 1 = Yampa River Section 1

2 Fish species present and percent composition - Cb(30) = 30% Chubs, CC(45) = 45% Channel Catfish, Br(5) = 5% Brown Trout, Sq(15) = 15% Squawfish

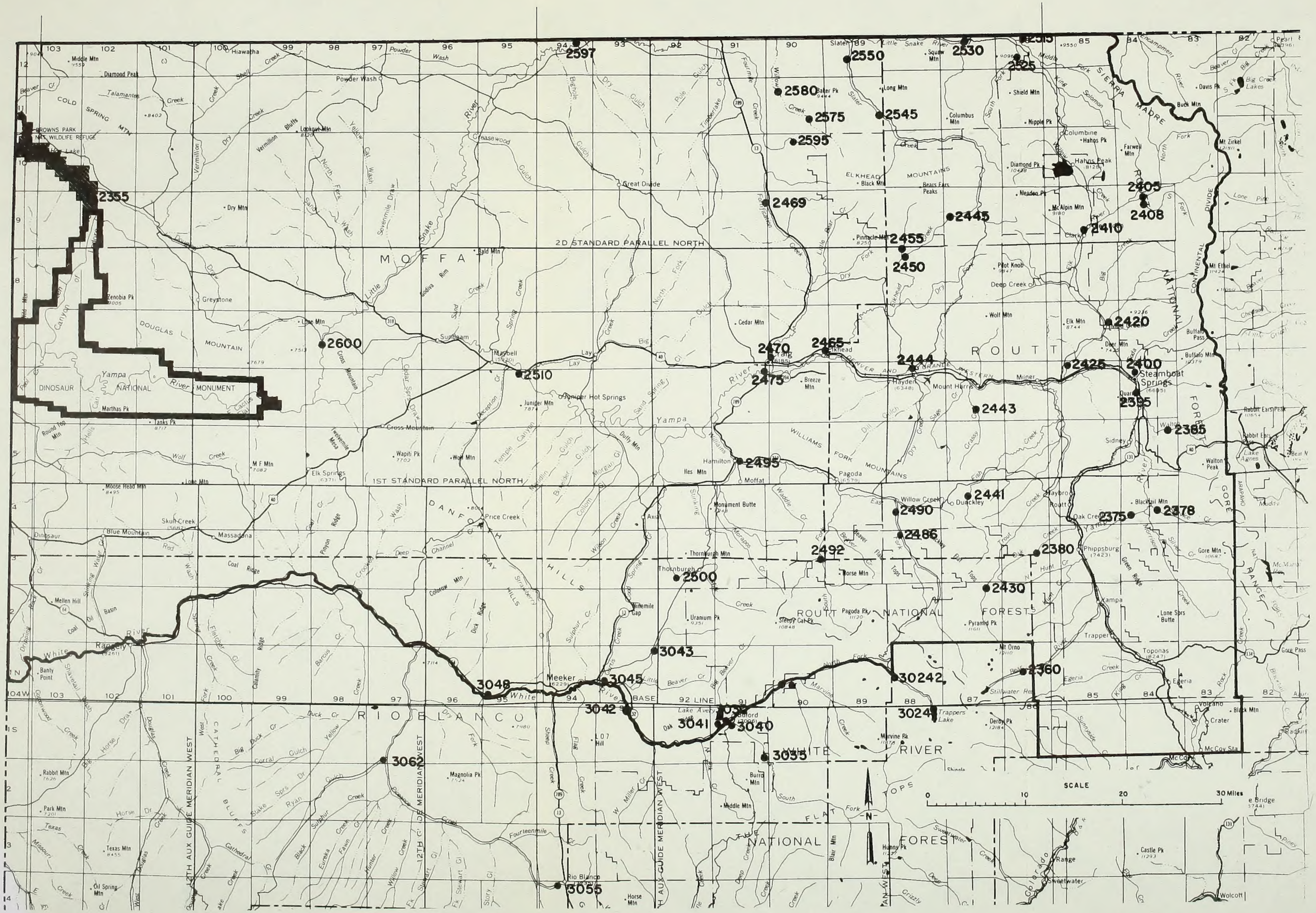
# 3 Stream fishery value rating — 60 and below = Poor; 61-74 = Fair; 75-85 = Good; 86 and above = Excellent

Other Abbreviations Used:

Stream Name C = Creek, F = Fork, S = South, N = North, E = East,

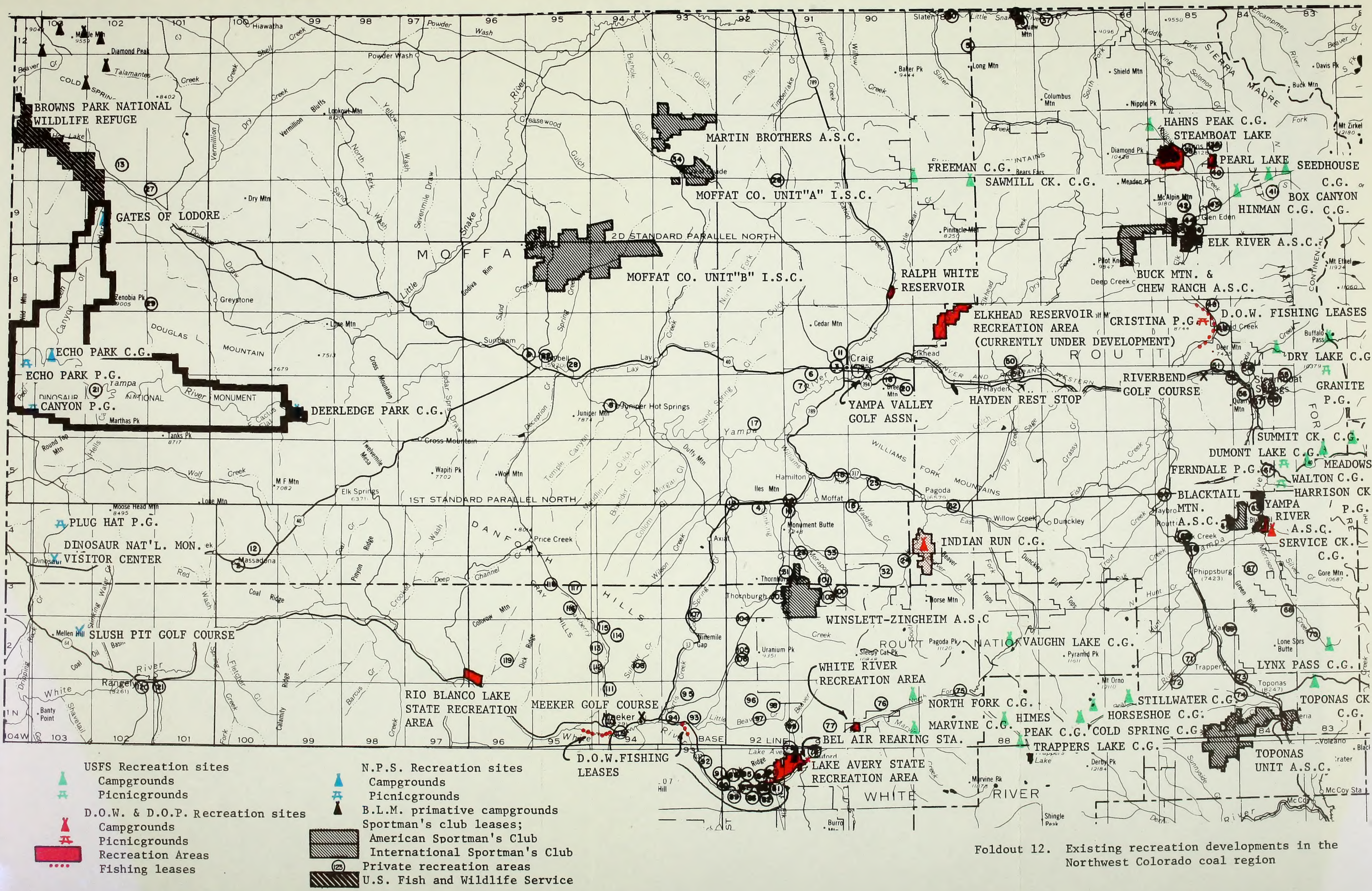
Fish species present B = Brook Trout, C = Cutthroat Trout, Rough = Rough Fish, S = Suckers, W = Whitefish, Ca = Carp, Sc = Sculpin

Foldout 10. Major stream fisheries in the analysis area

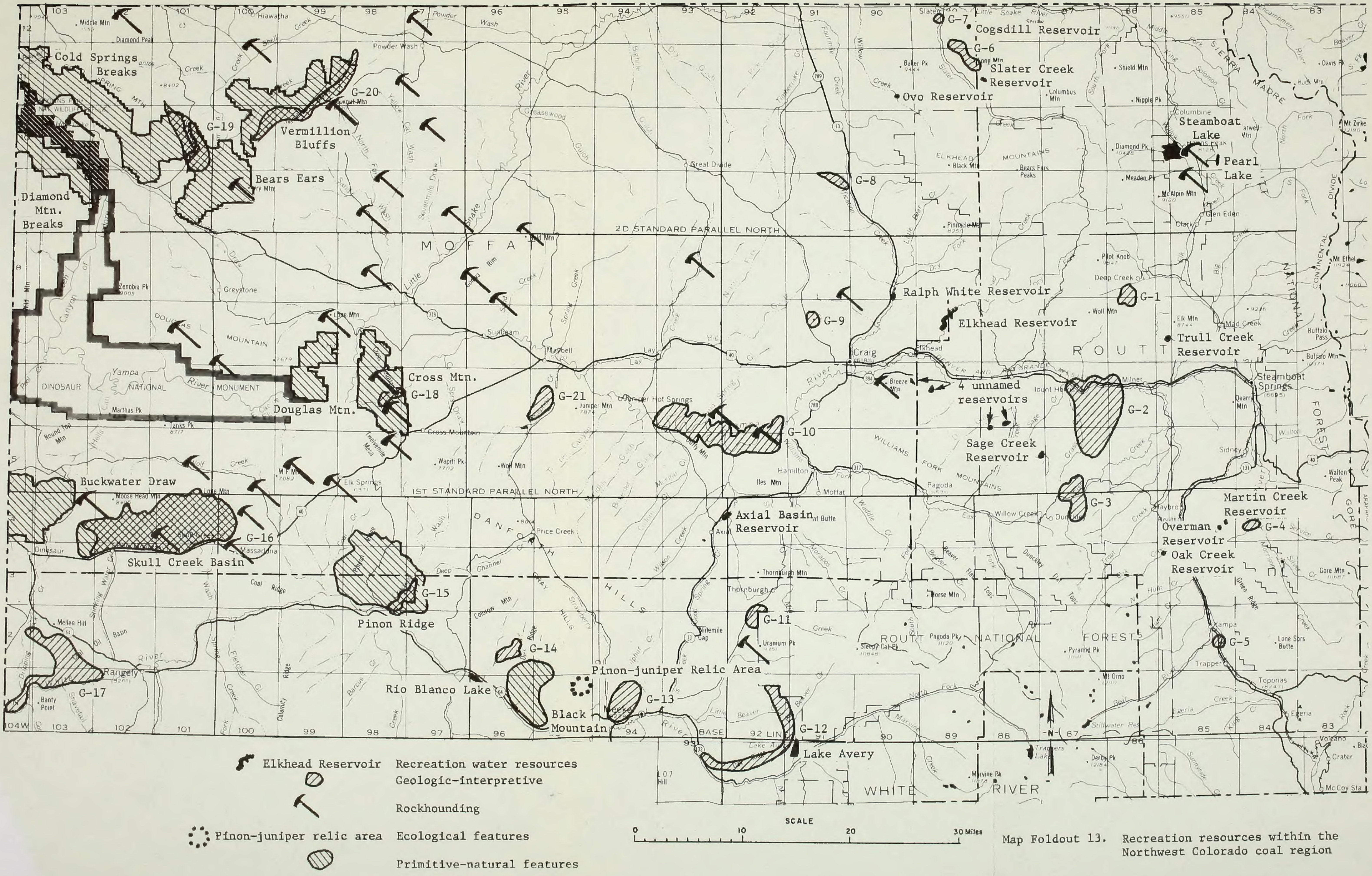


2534, an abbreviated identification number, refers to an 8 digit station number 09253400

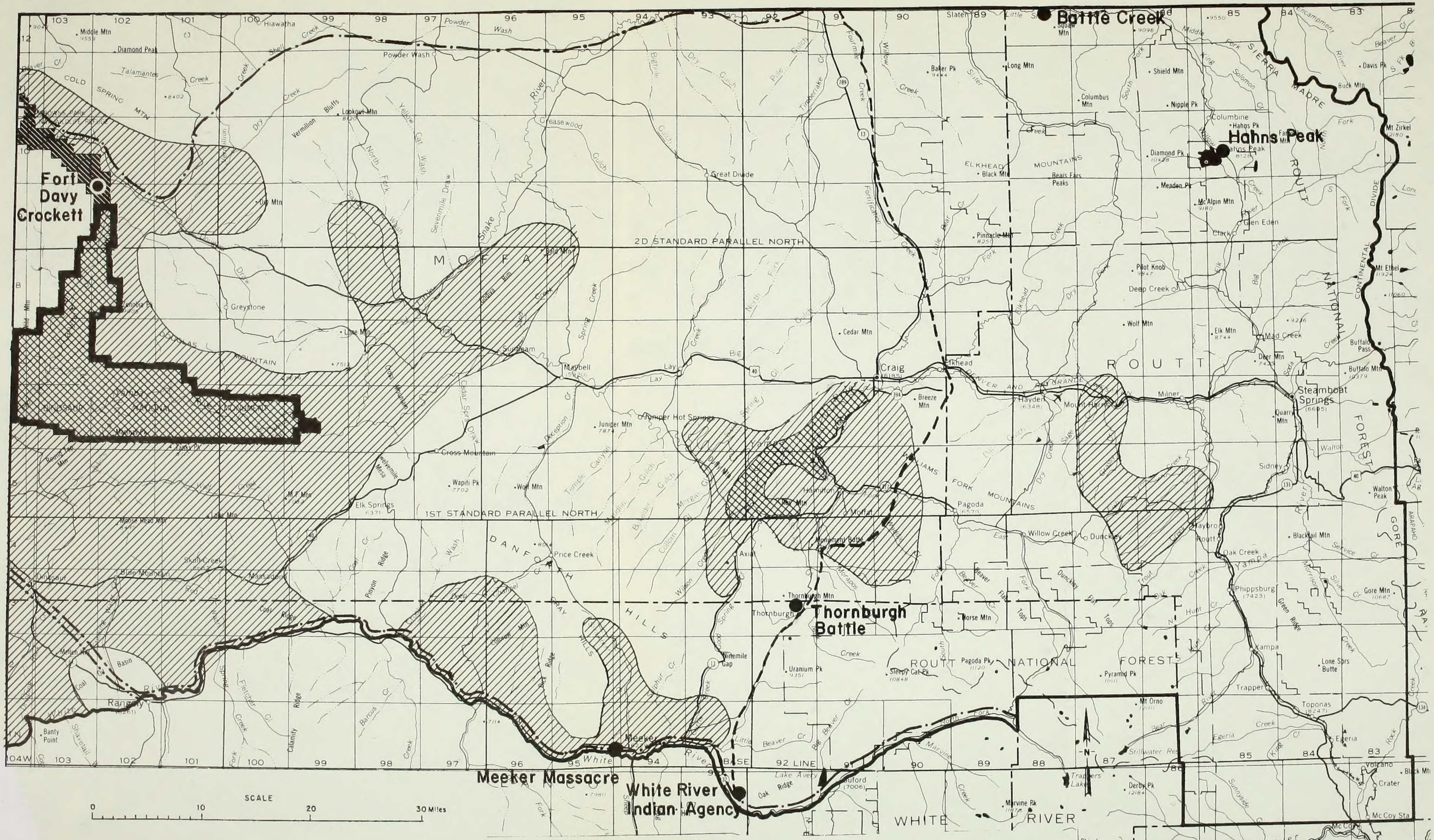
Map Foldout 11. Locations of surface water gaging stations



Foldout 12. Existing recreation developments in the Northwest Colorado coal region



Map Foldout 13. Recreation resources within the Northwest Colorado coal region



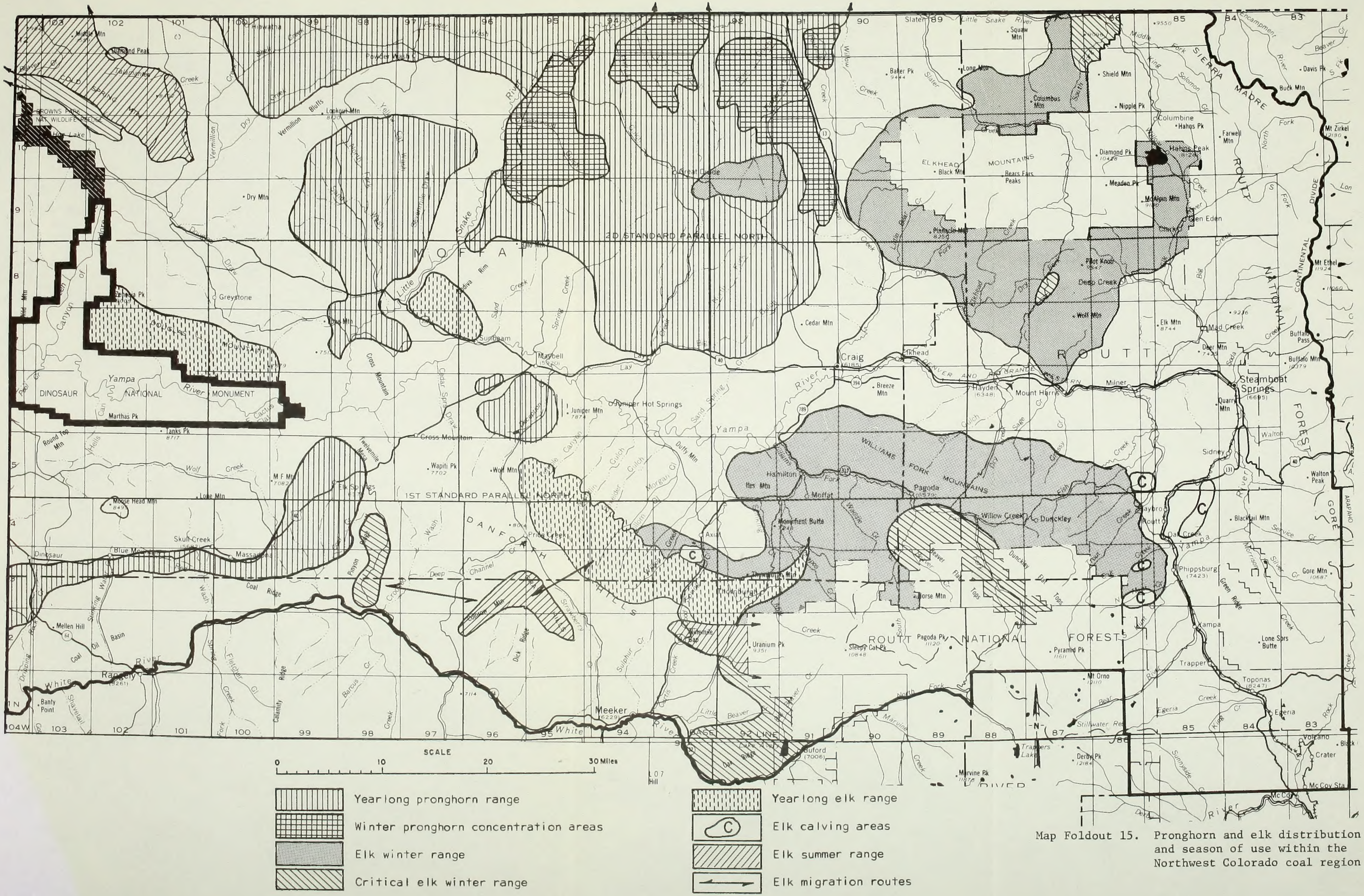
Historic trails and exploration routes:

- —··—··— Dominquez Escalante (1776)
- —·—·— Fremont Expedition (1844)
- — — — White River Indian Agency trail (1868)

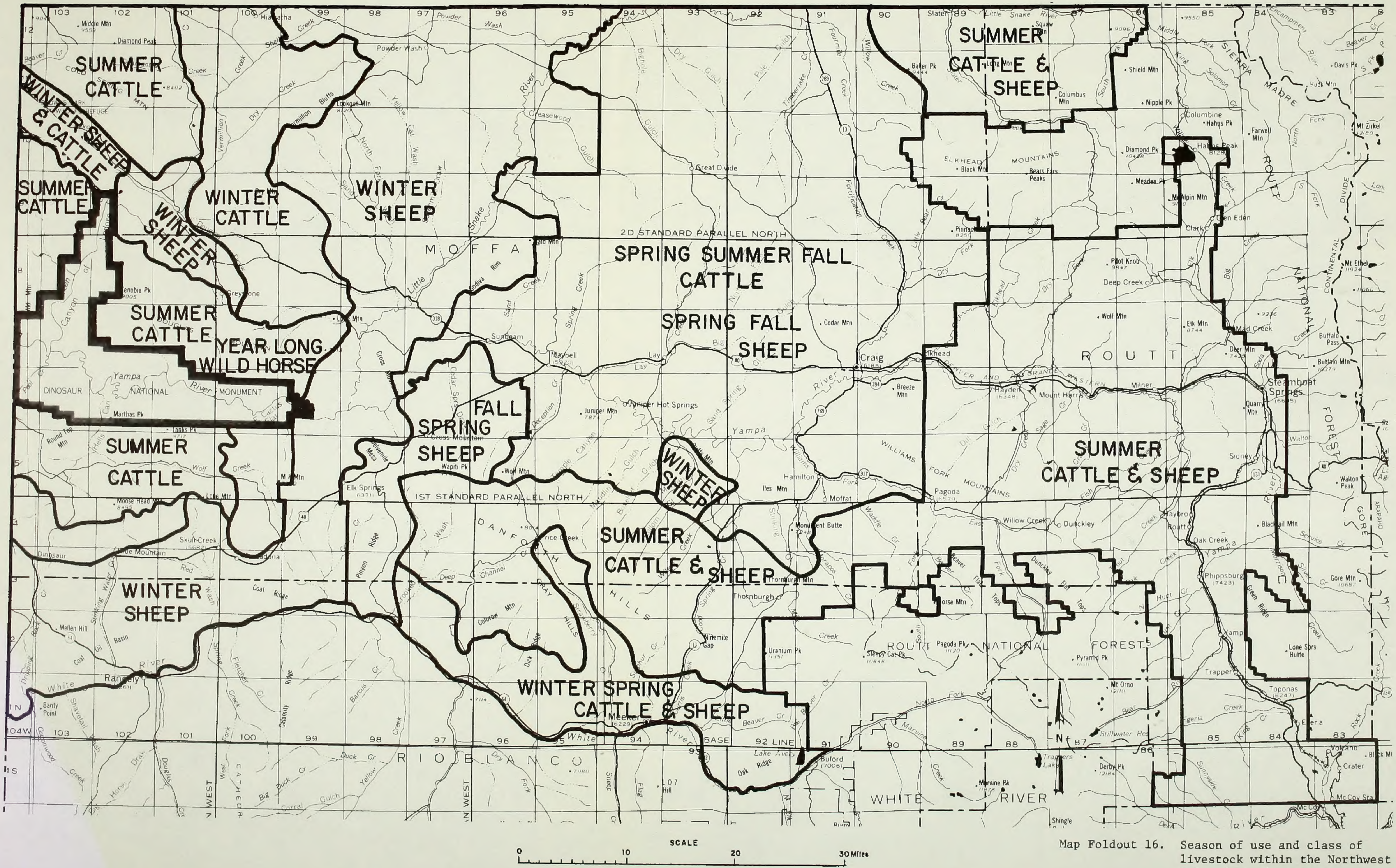
Archeological site density:

▩	High (approximately 1 site/section)
▨	Medium (approximately 1 site/township)
☐	Low (less than 1 site/township)

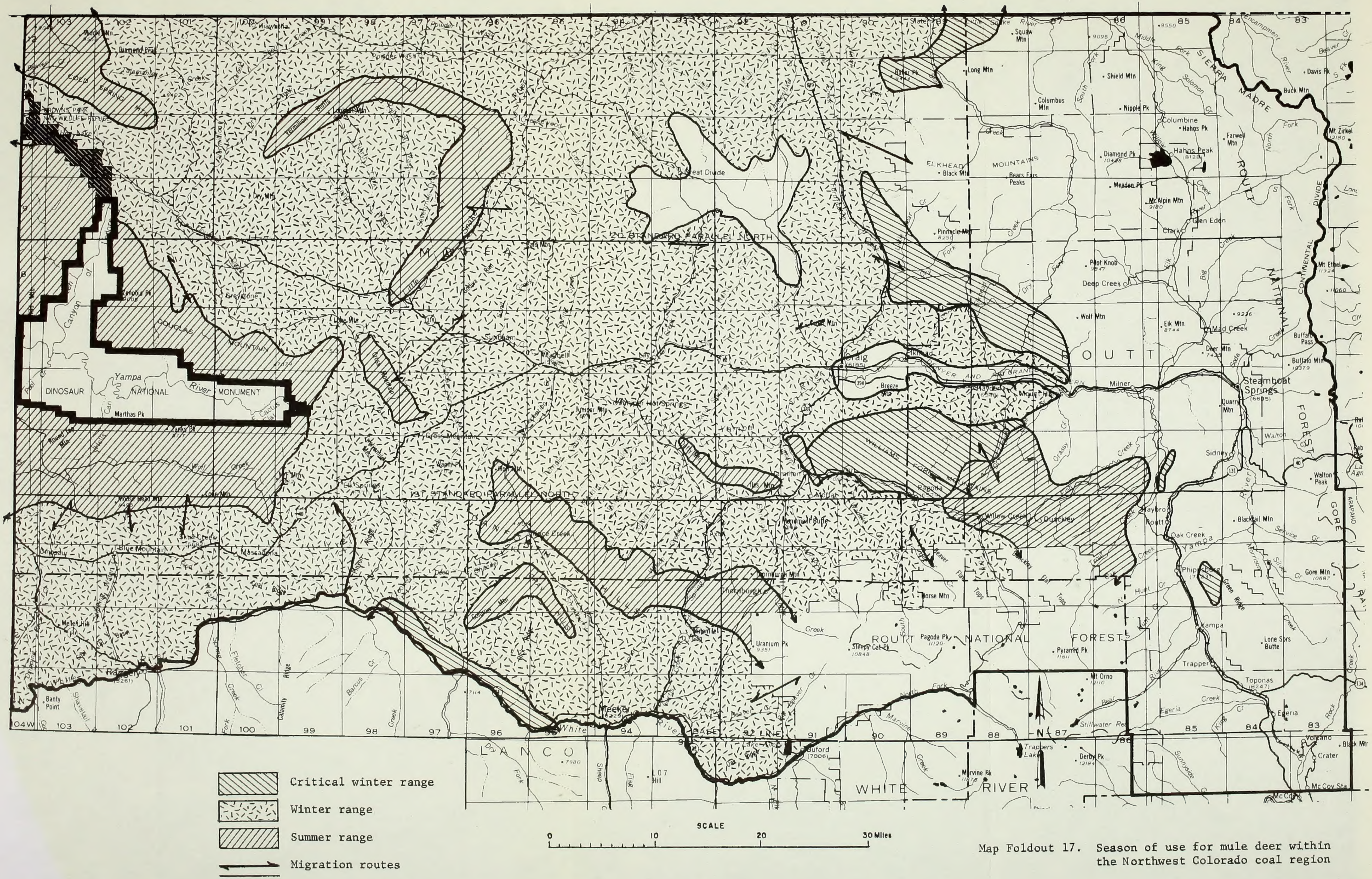
Map Foldout 14. Known archeological and historical resources (based on intensive survey of approximately one percent of the study region)



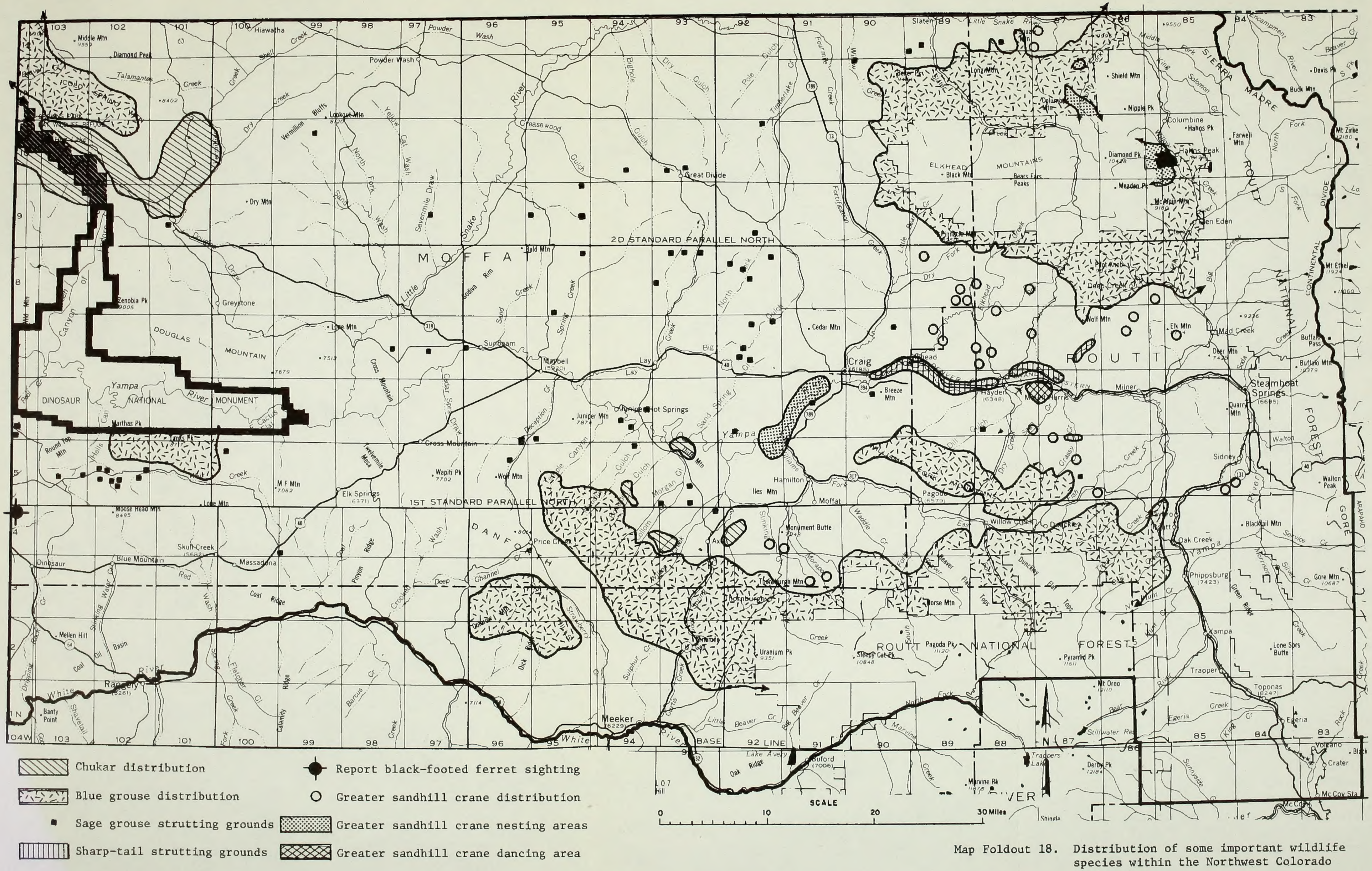
Map Foldout 15. Pronghorn and elk distribution and season of use within the Northwest Colorado coal region



Map Foldout 16. Season of use and class of livestock within the Northwest Colorado coal region



Map Foldout 17. Season of use for mule deer within the Northwest Colorado coal region



Map Foldout 18. Distribution of some important wildlife species within the Northwest Colorado coal region

Appendix C
Bibliography

BIBLIOGRAPHY

Abrassart, C. P., and Clough, G. A. "Juniper Mountain Area, Colorado", Rocky Mountain Association of Geologists and Intermountain Association of Geologists Guidebook, 1955, pp. 63-70.

Altshuller, A. P. "Atmospheric Sulfur Dioxide and Sulfate: Distribution of Concentrations at Urban and Non-urban Sites in the United States", Environmental Science and Technology: 7:8, 1973.

American Conference of Government Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment, 1972.

Anderson, K. "Dripping Rock Cave," Southwestern Lore 30, 1964, p. 26-35.

Andrewortha, H. G. Introduction to the Study of Animal Populations. Chicago: University of Chicago Press, 1972.

Armstrong, D. M. Distribution of Mammals in Colorado. Lawrence, Kansas: University of Kansas, 1972.

Athearn, Fredric J. Human Use and Occupation Narrative of the Craig, Colorado, District. Denver: Bureau of Land Management, October, 1975.

Averitt, P. Coking Coal Deposits of the Western United States. U.S. Geological Survey Bulletin 1222-G, 1966.

Bailey, M. and Niedrach, R. J. Birds of Colorado. Denver: Denver Museum of Natural History, 1965.

Bass, N. W., Eby, J. B. and Campbell, M. R. Geology and Mineral Fuels of Parts of Routt and Moffat Counties, Colorado. U.S. Geological Survey Bulletin 1027-D, 1955, pp. 143-250.

Bass, N. W., and Northrop, A. A. "Lower Paleozoic Rocks of the White River Uplift, Colorado", Rocky Mountain Association of Geologists and Intermountain Association of Geologists Guidebook, 1955, pp. 3-9.

Baughman, M. L. and Joskos, P. L. A Regionalized Electricity Model. Boston: Massachusetts Institute of Technology: Energy Laboratory Report MIT-EL 75-005, 1974.

Beckman, W. C. Guide to the Fishes of Colorado. Boulder, Colorado: University of Colorado Museum, 1974.

Berg, W. A. 1975a. "Revegetation of Land Disturbed by Surface Mining in Colorado." (In press).

Berg, W. A. "Changes Over Five Years in the Composition and Production of Seedings on Strip-Mine Spoils in Northwestern Colorado." Agronomy Department, Colorado State University, Unpublished Progress Report, 1975.

Berg, W. A. and Barrau, E. M. "Composition and Production of Seedings on Strip-Mine Spoils in Northwestern Colorado," First Research and Applied Technology Symposium on Mined Land Reclamation. Monroeville, Pennsylvania: Bituminous Coal Research Inc., 1973, pp. 215-224.

Bergin, M. J. "Uranium in Maybell-Lay area, Colorado". U.S. Geological Survey TEI-690, 1959, pp. 280-291.

Bergin, M. J. Preliminary Geologic Map of the Maybell-Lay Area, Moffat County, Colorado. U.S. Geological Survey Open-File Map, 1959.

Beroni, E. P., and McKeown, F. A. "Reconnaissance for Uraniferous Rocks in Northwestern Colorado, Southwestern Wyoming and Northeastern Utah." U.S. Geological Survey Trace Elements Environmental Report 308A, 1952.

Bickert, Brown, and Coddington. Attitudes and Opinions Related to the Development of an Oil Shale Industry: Regional Development and Land Use Study. Oil Shale Regional Planning Commission, 1973.

Blackmer, J. E. "Geology of the Steamboat Springs Area, Routt County, Colorado, with Special Emphasis on Thermal Springs". Boulder, Colorado: University of Colorado, Unpublished Master's Thesis, 1939.

Bohlen, D., et al. "The Blue List for 1975," American Birds, v. 38, Number 6, pp. 971-1974.

Borror, J. and White, E. A Field Guide to the Insects of America North of Mexico. Boston: Houghton Mifflin Company, 1970.

Bradley, W. A. "Geomorphology of the North Flank of the Uinta Mountains." U.S. Geological Survey Professional Paper 185-I, 1936, pp. 163-199.

Bradley, W. A. "Geology of Green River Formation and Associated Eocene Rocks in Southwestern Wyoming and Adjacent Parts of Colorado and Utah." U.S. Geological Survey Professional Paper 496-A, 1964.

Bradley, W. A. "Jurassic and Pre-Mancos Cretaceous Stratigraphy of the Eastern Uinta Mountains, Utah-Colorado", Rocky Mountain Association of Geologists Guidebook, 1955, pp. 21-25.

Brainerd, A. E., and Carpen, T. R. "History of Exploration and Development for Oil and Gas in Northwestern Colorado", Rocky Mountain Association of Geologists Guidebook, 1962, pp. 23-33.

Breternitz, D. A. Archaeological Appraisal of Proposed Hayden and Yampa/Williams Fork Power Plant. Boulder, Colorado: University of Colorado Museum, MS on file, 1970.

Breternitz, D. A. Archaeological Resources within Coal Stripping Area Williams Fork Mountains, Moffat County, Colorado. Boulder, Colorado: University of Colorado Museum, MS on file, 1972.

Breternitz, D. A. Archaeological Survey in Dinosaur National Monument Colorado-Utah. Boulder, Colorado: University of Colorado Museum, MS on file, 1963.

Breternitz, D. A. Archaeological Survey of the Savery Pothook Reservoir Area - Colorado, Wyoming. Boulder, Colorado: University of Colorado, MS on file, 1964.

Breternitz, D. A. Report to the Stearn-Rogers Corporation Routt County. Boulder, Colorado: University of Colorado Museum, MS on file, 1971.

Briggs, G. S. Some Recent Analyses of Plume Rise Observation. Washington: Second International Clean Air Congress of the International Union of Air Pollution Prevention Association, 1970.

Brown, E., Skougstad, M. W. and M. J. Fishman. Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. Washington, D.C., 1974.

Brown, H. E. "Gambel Oak in West Central Colorado", Ecology 39, 1958, pp. 317-327.

Buckles, W. G. "Archeology in Colorado: Historic Tribes", Southwestern Lore, 34, 1968, pp. 53-67.

Burbank, W. A., Lovering, T. S., Goddard, E. N., and Eckel, E. B. "Geologic Map of Colorado". U.S. Geological Survey in cooperation with Colorado State Geological Survey Board and Colorado Metal Mining Fund, 1935 (Reprinted 1967).

Burt, H. and Grossenheider, P. A Field Guide to the Mammals. Boston: Houghton Mifflin Company, 1952.

Cadigan, R. A. "Geochemical Anomalies and Alteration in the Moenkopi Formation, Skull Creek, Moffat County, Colorado." U.S. Geological Survey Professional Paper 761, 1972.

Calder, K. L. A Climatological Model for Multiple Source Urban Air Pollution. Proceedings of the Second Meeting of the Expert Panel on Air Pollution Modeling, 1971.

Campbell, M. R. The Twentymile Park District of the Yampa Coal Field, Routt County, Colorado. U.S. Geological Survey Bulletin 748, 1923.

Cashion, W. B. Geology and Fuel Resources of the Green River Formation Southeastern Uinta Basin, Utah and Colorado. U.S. Geological Survey Professional Paper 548, 1967.

Charlson, R. J., et al. Journal of Air Pollution Control Association, 19, 1969, p. 937.

Cobban, W. A. "Late Cretaceous Fossil Zones of the Powder River Basin, Wyoming and Montana," Wyoming Geology Association Guidebook. 13th Annual Field Conference, Powder River Basin, Wyoming, 1958, pp. 114-119.

Cobban, W. A., and Reeside, J. A., Jr. "Correlation of the Cretaceous Formations of the Western Interior of the United States," Bulletin of the Geological Society of America, v. 63, no. 10, pp. 1011-1044.

Cochran, W. Mine Subsidence - Extent and Cost of Control in a Selected Area. U.S. Department of the Interior, Bureau of Mines IC 8507, 1971.

Code of Federal Regulations, Title 50, Part 17. Conservation of Endangered Species and Other Fish and Wildlife (January 1) 1971.

Colorado Air Pollution Control Commission. Ambient Air Standards for Metropolitan Denver Air Quality Control Region, Air Quality Control Areas, and the State of Colorado. Denver, Colorado, 1970.

Colorado Air Pollution Control Commission. Regulation No. 1, Emission Control Regulations for Particulates, Smokes, and Sulfur Oxides for the State of Colorado. Denver, Colorado, 1971.

Colorado Department of Health. Colorado State Plan for Construction of Hospitals and Health Facilities, 1975.

Colorado Department of Health. Green River Basin Water Quality Management Plan. Denver: McCall-Ellingson and Morrill, Inc., 1974.

Colorado Department of Health. Regulations for Effluent Limitations. Denver, Colorado: Water Quality Control Commission, 1975.

Colorado Department of Health. Water Quality Standards and Stream Classification. Denver, Colorado: Water Quality Control Commission, 1974.

Colorado Division of Highways. Average Daily Traffic Volume Maps, 1965, 1970, 1974.

Colorado Division of Highways. Rifle External Origin and Destination Study, Project F-013-1(21), 1973.

Colorado Division of Highways. Steamboat Springs External Origin and Destination Study, Project F-040-2(2), 1972.

Colorado Division of Parks. Interim Colorado Comprehensive Outdoor Recreation Plan, 1974.

Colorado Division of Water Resources, Division 6. Annual Report, 1974.

Colorado Division of Wildlife, Birds of Colorado - Critical Status List, 1975.

Colorado Division of Wildlife. 1973 Colorado Big Game Harvest, DOW-M-M-22-'73, 1974.

Colorado Division of Wildlife. Fisheries Inventory, 1972.

Colorado Division of Wildlife. Fishery Questionnaire for 1974, 1975.

Colorado Division of Wildlife. Small Game Harvest Report, 1973.

Colorado Division of Wildlife. The Strategy of Today for Wildlife Tomorrow, v. 1, 1974.

Colorado Division of Wildlife. Stream and Lake Inventory Forms. Denver, 1972.

Colorado Land Use Commission. Colorado Land Use. Map folio, 1974.

Colorado, The State Historical Society of. Guidelines for Identification and Designation of Historical, Natural and Archaeological Resources. Denver, Colorado.

Colorado, University of, Graduate School of Business Administration, Business Research Division. Colorado and Regional Population Estimates - 1970-1980; Methods and Results. Boulder, Colorado, 1974.

Colorado-Ute Electric Association, Inc. Yampa Project -- Environmental Analysis, 1974.

Colorado Water Conservation Board and U.S. Department of Agriculture. Water and Related Land Resources, Yampa River Basin in Colorado, 1969, p. 92.

Cowherd, C., Jr. Development of Emission Factors of Fugitive Dust Courses, Presented at Air Pollution Control Association Annual Meeting, 1974.

Cullins, H. L. Geologic Map of the Banty Point Quadrangle, Rio Blanco County, Colorado. U.S. Geological Survey Geological Quadrangle Map GQ-703, 1968.

Cullins, H. L. Geologic Quadrangle Map of the Rangely Quadrangle, Rio Blanco County, Colorado. U.S. Geological Survey Map GQ-903, 1971.

Cummings, A. B. and Given, I. A. SME Mining Engineering Handbook, 1973.

Dames and Moore. Draft for Environmental Baseline Input for Energy Fuels Proposed Coal Mine Sites. Denver, 1975.

Dames and Moore. Mine Plans, Lease Applications and Environmental Considerations Energy 1, 2 and 3 Mines, Routt County, Colorado. Denver, 1975.

Daubenmire, R. Plant Communities: A Textbook of Plant Synecology. New York: Harper and Row Publishers, 1968.

Davis, W. A. Birds in Western Colorado. Colorado Field Ornithological, 1969.

de Chiara, J., and Koppelman, L. Planning Design Criteria. New York: Van Nostrand Reinhold Company, 1969.

del Rio, S. M. (compiler) Mineral Resources of Colorado, (first sequel). Denver, Colorado: Colorado Mineral Resources Board, 1960.

Dorf, E. "Paleobotanical Correlations of the Cretaceous Deposits in Southwestern Wyoming," Wyoming Geology Association Guidebook. 10th Annual Field Conference 1955, pp. 96-99.

Dorf, E. Upper Cretaceous Floras of the Rocky Mountain Region. Washington: Carnegie Institute, Public Number 508, 1938, pp. 1-78.

Dupree, W. G., Jr. and West, J. A. United States Energy Through the Year 2000. U.S. Department of the Interior, 1972.

Dyni, J. R. Geologic Map of the Elk Springs Quadrangle, Moffat County, Colorado. U.S. Geological Survey Geological Quadrangle Map GQ-702, 1968.

Economic Report of the President, 1975.

Eisenmann, E., et al. "Thirty-Second Supplement to the American Ornithologists Union Check-List of North American Birds." The Auk, v. 90, 1973, pp. 411-419.

Everhart, W. H., and Seaman, W. R. Fishes of Colorado. Denver: Colorado Game, Fish and Parks Division, 1971.

Fennemann, N. M. Physiography of Western United States. New York: McGraw-Hill, 1931.

Fenneman, N. M., and Gale, H. S. The Yampa Coal Field, Routt County, Colorado. U.S. Geological Survey Bulletin 297, 1906.

Frank, N. H. Temporal and Spatial Relationships of Sulfates, Total Suspended Particulates and Sulfur Dioxide. Paper presented at the 67th Annual Meeting of the Air Pollution Central Association, 1974.

Gale, H. S. Carnotite and Associated Minerals in Western Routt County, Colorado. U.S. Geological Survey Bulletin, 340-D, 1908, pp. 257-262.

Gale, H. S. Carnotite in Rio Blanco, Colorado. U.S. Geological Survey Bulletin, 315-C, 1907, pp. 110-117.

Gale, H. S. Coal Fields of Northwestern Colorado and Northeastern Utah. U.S. Geological Survey Bulletin 341, 1907, pp. 283-315.

Gale, H. S. Coal Fields of Northwestern Colorado and Northwestern Utah. U.S. Geological Survey Bulletin 415, 1910.

Gale, H. S. Coal Fields of the Danforth Hills and Grand Hogback in Northwestern Colorado. U.S. Geological Survey Bulletin 316-E, 1906, pp. 264-301.

Gale, H. S. The Hahns Peak Gold Field. U.S. Geological Survey Bulletin 316-E, 1906, pp. 28-34.

Gilmore, J. S., and Duff, M. K. The Sweetwater Country Boom: A Challenge to Growth Management, 1974.

Girard, G. L. Life History, Habit and Food of the Sage Grouse, Centrocercus Urophasianus. Laramie, Wyoming: University of Wyoming, 1937.

Graul, W. D. Population Status and Seasonal Status of the Species and Subspecies of Birds of Colorado. Colorado Division of Wildlife, 1975.

Grossman, M. L. and Hamlet, J. Birds of Prey of the World. New York: Bonanza Books, 1964.

Hail, W. J., Jr. Geologic Map of the Smizer Gulch Quadrangle, Rio Blanco and Moffat County, Colorado. U.S. Geological Survey Map GQ-1131, 1973.

Hancock, E. T. Geology and Coal Resources of the Axial and Monument Butte Quadrangles, Moffat County, Colorado. U.S. Geological Survey Bulletin 757, 1925.

Hancock, E. T., and Eby, J. B. Geology and Coal Resources of the Meeker Quadrangle, Moffat and Rio Blanco Counties, Colorado. U.S. Geological Survey Bulletin 812-C, 1930, pp. 191-242.

Hansen, W. R. Geology of the Flaming Gorge Area Utah-Colorado-Wyoming. U.S. Geological Survey Professional Paper 490, 1965.

Hansen, W. R. The Geologic Story of the Uinta Mountains. U.S. Geological Survey Bulletin 1291, 1969.

Haun, J. D. "Introduction to the Geology of Northwestern Colorado", Rocky Mountain Association Geology Guidebook, 14th Annual Field Conference, Exploration for Oil and Gas in Northwestern Colorado, 1962, pp. 1-14.

Hewitt, G. B., Huddliston, E. W., Lavigne, R. G., Ueckert, D. N., and Watts, J. G. Rangeland Entomology. Denver: Society of Range Management, 1974.

Hidy, G. M., et al. Characteristics of Aerosols in California (ACHEX). Final Report to California Air Resources Board v. IV. Thousand Oaks, California: Science Center, Rockwell International, Report SC524.25FR., 1975.

Hofstra, W. E., Moran, R. E. and Leavesley, G. H. Environmental Resources Analysis for the Grace Site in Southern Moffat County, Colorado. U.S. Geological Survey, 1975.

Holden, P. B. "Distribution, Abundance and Life History of the Fishes of the Upper Colorado River Basin." Logan, Utah: Utah State University, 1972.

Holden, P. B., and Stalnaker, C. B. "Distribution of Fishes in the Dolores and Yampa River Systems of the Upper Colorado River Basin." Southwestern Naturalist. (In press).

Holzworth, G. C. Mixing Heights, Wind Speeds and Potential for Urban Air Pollution Throughout the Contiguous United States. U.S. Environmental Protection Agency, 1972.

Hornbaker, A. L., and Holt, R. D. 1972 Summary of Coal Resources in Colorado. Colorado Geological Survey, 1973.

Howell, J. V. (ed). Glossary of Geology and Related Science. Washington, D.C.: American Geological Institute, 1957.

Hylander, C. J. Wildlife Communities from Tundra to the Tropics in North America. Boston: Houghton Mifflin Company, 1966.

Isachsen, Y. W. "Uranium Deposits in the Skull Creek and Uranium Peak Districts, Northwest Colorado", Rocky Mountain Association of Geologists Guidebook, 1955, pp. 124-125.

James, J. W., and Marr, J. W. Route 40 Mountain Environment Transect for Colorado and Utah. Boulder: Institute of Arctic and Alpine Publication, University of Colorado, 1966.

Jennings, C. H. Cultural and Paleontological Resources, Federal Oil Shale Lease Tract C-b. Woodward-Clyde Consultants, 1975.

Jennings, J. D. Prehistory of North America. New York: McGraw-Hill, 1968.

Jones, B. Viewpoints of Craig Residents About Growth In Their Community. Social Change Systems, Inc., 1974.

Kanizay, S. P. "Geology of Cross Mountain, Moffat County, Colorado." Golden, Colorado: Colorado School of Mines, Unpublished Doctor's Thesis, 1938.

Keroher, G., et al. Lexicon of Geologic Names of the United States. U.S. Geological Survey Bulletin 1200, Parts 1, 2 and 3, 1966.

Kormondy, E. J. Concepts of Ecology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969.

Kucera, R. C. "Cretaceous Stratigraphy of the Yampa District, Northwest Colorado", Rocky Mountain Association of Geologists Guidebook, 1959, pp. 37-45.

Kufeld, R. C., Wallmo, O. C. and Feddema, C. Foods of the Rocky Mountain Mule Deer. U.S. Forest Service, 1973.

Lack, D. The Natural Regulation of Animal Numbers. Great Britain: Oxford University Press, 1954.

Lamont, W., et al. Tax Lead Time Study. Colorado Geological Survey, 1974.

Landis, E. R., Coal Resources of Colorado, U.S. Geological Survey Bulletin 1072-C, 1959.

Larsen, R. I. "An Air Quality Data Analysis System for Interrelating Effects, Standards, and Needed Source Reductions - Part 2", Journal of Air Pollution Abstracts 24, 1974.

Larson, T. G. "Stratigraphy of the Steamboat Springs Area, Colorado", Rocky Mountain Association of Geologists and Intermountain Association of Petroleum Geologists Guidebook, 1955, pp. 10-11.

Lauman, G. W. "Geology of the Iles Mountain Area, Moffat County Northwestern Colorado". Golden, Colorado: Colorado School of Mines, Unpublished Master's Thesis, 1965.

Lechleitner, R. R. Wild Mammals of Colorado. Boulder, Colorado: Pruett Publishing Company, 1969.

Litton, R. B., Jr. Forest Landscape Description and Inventories. U.S. Forest Service Research Paper, PSW-49, 1968.

Lowrie, R. L., Recovery Percentage of Bituminous Coal Deposits in the United States. U.S. Department of the Interior, Bureau of Mines RI 7109, 1968.

McKay, E. J. Geological Map of the Lone Mountain Quadrangle, Moffat County Colorado. U.S. Geological Survey Geologic Quadrangle Map 6Q-1144, 1974.

McKay, E. J. Oil Shale Beds in the Green River and Wasatch Formation in the Little Snake River Area of Northwestern Colorado. U.S. Geological Survey Professional Paper 750-D, 1972, pp. D9-D12.

McKay, E. J., and Bergin, M. J. Geologic Map of the Maybell Quadrangle, Moffat County, Colorado. U.S. Geological Survey Geologic Quadrangle Map GQ-1145, 1974.

McKee, J. E., and Wolf, H. W. Water Quality Criteria. California Water Resources Control Board: Publication 3-A, 1963.

McKenna, M. C. "Earliest Eocene Vertebrates from the Sand Wash Basin, Northwest Colorado," Guidebook to the Geology of Northwest Colorado. Intermountain Association Petroleum Geologists, Rocky Mountain Association of Geology, 1955, pp. 41-45.

McNay, L. M. Coal Refuse Fires, An Environmental Hazard. Bureau of Mines Information Circular, U.S. Department of Interior, 1971.

Martin, A. C., Zim, H. S., and Nekon, A. L. American Wildlife and Plants: A Guide to Wildlife Food Habits. New York: Dover Publications, Inc., 1951.

Maslin, T. P. An Annotated Check List of the Amphibians and Reptiles of Colorado. Boulder, Colorado: University of Colorado, 1959.

Masters, C. D. "Fort Union Formation, Eastern Sand Wash Basin, Colorado", Wyoming Geological Association 16th Annual Field Conference, Symposium on Lake Cretaceous Rocks of Wyoming, 1961, pp. 125-128.

Miller, A. E. Geologic, Energy and Mineral Resources Maps of Routt County, Colorado. Colorado Geological Survey, Map Series 1, 1975.

"Mineral Leasing Act for Acquired Lands," U.S. Code, v. 30, 1973.

Minkley, W. L., and Deacon, J. E. "Southwestern Fishes and the Enigma of 'Endangered Species'", Science 159. 1968, pp. 1424-1432.

Moffat County, Moffat County Zoning Resolution, 1962.

Morrison-Knudsen Company. W. R. Grace Coal Haul Railroad, Taylor Creek to Craig, Colorado, Feasibility Study. Boise, Idaho, 1975.

National Academy of Science. "The Relationship of Emissions to Ambient Air Quality for the Committee on Public Works", Air Quality and Automobile Emission Control, v. III. U.S. Senate, 93-124, 1974.

National Petroleum Council, Committee on U.S. Energy Outlook. New Energy Forms Task Group 1971-1985, 1972.

Ninety-third Congress. Public Law 93-621, S.3022, 1975.

Norman, R. L. et al. Using Wildlife Values in Benefit/Cost Analysis and Mitigation of Wildlife Losses. Colorado Division of Wildlife.

Northern Great Lakes Resource Program. Atmospheric Aspects Work Group Report, 1974.

Odum, E. P. Fundamentals of Ecology. Philadelphia: W. B. Sanders Company, 1959.

Oklahoma, University of. Energy Alternatives: A Comparative Analysis. Norman, Oklahoma: The Science and Public Policy Program of the University of Oklahoma, 1975.

Osterwald, F. W., and Dean, B. G. Preliminary Tectonic Map of Northern Colorado and Northeastern Utah Showing the Distribution of Uranium Deposits. U.S. Geological Survey, Mineral Investigations Field Studies Map, MF 130, 1958.

Parker, B. H., Jr. "The Geology of the Gold Placers of Colorado". Golden, Colorado: Colorado School of Mines, Unpublished Doctors's Thesis, 1961.

Patterson, R. L. The Sage Grouse in Wyoming. Denver: Sage Books Inc., 1952.

Peabody Coal Company. Environmental Impact Report, Seneca 2-W. Seneca Coals, Ltd., 1975.

PEDCO - Environmental Specialists, Inc. Investigation of Fugitive Dust - Sources, Emissions and Control. U.S. Environmental Protection Agency Contract 68-02-0044, 1973.

Peterson, R. T. A Field Guide To Western Birds. Boston: Houghton Mifflin Company, 1941.

Phillipson, J. Ecological Energetics. London: Edward Arnold Publishers Ltd., 1966.

Plummer, P. A. Restoring Big Game Range in Utah. Utah Division of Fish and Game, Publication Number 68-3.

Poole, F. G., and Stewart, J. H. "Chinle Formation and Glen Canyon Sandstone in Northeast Utah and Northwest Colorado", Intermountain Association of Petroleum Geologists Guidebook, 1964, pp. 93-103.

Public Law 93-205, 93rd Congress, S. 1983. Endangered Species Act of 1973, (December 28), 1973.

Public Law 95-624, 85th Congress, H. R. 13188. Fish and Wildlife Coordination Act, (August 12), 1958.

Radosevich, G. E., and Hamburg, D. H. Colorado Water Laws, Compacts, Treaties, and Selected Cases. Colorado Division of Water Resources (State Engineer's Office), 1971.

Raup, D. M. and Stanley, S. M. Principles of Paleontology. San Francisco: W. H. Freeman and Company, 1971.

Reid, G. K. Ecology of Inland Waters and Estuaries. New York: Van Nostrand Reinhold Company, 1961.

Richmond, M. Land Animals. Annals of the New York Academy of Sciences. v. 216, 1973, pp. 121-127.

Rio Blanco County. Rio Blanco County Zoning Ordinance, 1974.

Rio Blanco County Planning Department. Meeker Opinion Survey, 1975.

Ritzma, H. R. "Early Cenozoic History of the Sand Wash Basin, Northwest Colorado", Intermountain Association of Geologists 16th Annual Field Conference, Geology of Northwest Colorado, 1955.

Robbins, C. S., Brunn, B. and Zim, H. S. A Guide to Field Identification: Birds of North America. New York: Golden Press, 1966.

Robinson, P., Black, C., McKenna, M., (ed.) Field Conference Guidebook for the High Altitude and Mountain Basin Deposits of Miocene Age in Wyoming and Colorado. Boulder, Colorado: University of Colorado, 1968.

Rohler, H. W. "Mineral Resources in the Washakie Basin, Wyoming, and Sand Wash Basin, Colorado", Wyoming Geological Association Guidebook. 25th Field Conference, 1973, pp. 47-56.

Rogers, G. E. Sage Grouse Investigations in Colorado. State of Colorado: Technical Publication 16, 1964.

Rogers, G. E. The Blue Grouse in Colorado. State of Colorado: Technical Publication 21, 1968.

Rogers, G. E. The Sharp-Tail Grouse in Colorado. State of Colorado: Technical Publication 23, 1969.

Routt County. Routt County Zoning Resolution, 1972.

Sears, J. D. Geology and Oil and Gas Prospects of Part of Moffat County, Colorado and Southern Sweetwater County, Wyoming. U.S. Geological Survey Bulletin 751-G, 1924.

Sears, J. D. "Relations of the Browns Park Formation and the Bishop Conglomerate and Their Role in the Origin of the Green and Yampa Rivers". Geological Society of American Bulletin, v. 35, 1924, pp. 279-304.

Sears, J. D. Yampa Canyon in the Uinta Mountains, Colorado. U.S. Geological Survey Professional Paper 374-I, 1962.

Segerstrom, K., and Young, E. J. General Geology of the Hahns Peak and Farwell Mountain Quadrangles, Routt County, Colorado, (with a discussion of Triassic and Jurassic Rocks, by G. N. Pipiringos). U.S. Geological Survey Bulletin 1349, 1972.

Sindelar, B. W., Hadder, R. L. and Majerus, M. E. Surface Mined Land Reclamation Research in Montana. Bozeman, Montana: Montana Agricultural Experiment Station, Montana State University, Research Report 40, 1973.

Smith, M. (ed.) Recommended Guide for the Prediction of the Dispersion of Airborne Effluents. New York: American Society of Mechanical Engineers, 1968.

Spaulding, W. M., Jr. and Ogden, R. D. Effects of Surface Mining on Fish and Wildlife Resources of the United States. Bureau of Sport Fisheries and Wildlife Resource Publication 68, 1968, p. 51.

Speltz, N. Strippable Coal Resources of Colorado. U.S. Department of the Interior, Bureau of Mines, PR 195, 1974.

Spencer, R. F., Jennings, J. D., et al. The Native Americans. New York: Harper and Row, 1965.

Stebbings, R. C. A Field Guide to Western Reptiles and Amphibians. Boston: Houghton Mifflin Company, 1966.

Stewart, R. Microbial Studies on the Reclamation of Strip-Mined Spoils. Montana State University: Progress report, Montana Agricultural Experiment Station, 1974.

Theobald, P. K. Preliminary Geologic Map of the North Half of the Craig Quadrangle, Moffat County, Colorado. U.S. Geological Survey Open-File Map, 1970.

Turner, D. B. "A Diffusion Model for an Urban Area", Journal of Applied Meterology 3, 1964, pp. 83-91.

Turner, D. B. Workbook of Atmospheric Dispersion Estimates. Cincinnati: U.S. Department of Health, Education and Welfare, Public Health Service, 1972.

Turner, D. S. "Controls of Oil and Gas Accumulation". Rocky Mountain Association of Geologists Guidebook, 1962, pp. 29-33.

Tweto, O. Preliminary Geologic Map of the Craig 1° x 2° Quadrangle, Utah and Colorado. U.S. Geological Survey Open-File Map, 1975.

Unterman, G. E., and Unterman, B. R., "Geology of the Eastern End of the Uinta Mountains, Utah-Colorado". Rocky Mountain Association of Geologists Guidebook, 1955, pp. 17-20.

U.S. Bureau of Census. Current Population Reports, 1975, pp. 25, 605.

U.S. Bureau of Land Management. Endangered Species Pamphlets, Denver, 1973.

U.S. Bureau of Land Management. Great Divide Unit Resource Analysis, Vegetation Section, Little Snake Resource Area, Craig District Office, 1972.

U.S. Bureau of Land Management. Letter of Intent Energy Fuels Corporation, 1975.

U.S. Bureau of Land Management. Meeker and Rangely Unit Resource Analyses. Recreation Section, White River Resource Area. Craig District Office, 1974.

U.S. Bureau of Land Management. Statement of Mining Plan, Sun Mine Project, 1975.

U.S. Bureau of Land Management. Vermillion Unit Resource Analyses - Management Framework Plan. Recreation Section, Little Snake Resource Area, Craig District Office, 1972.

U.S. Bureau of Land Management. Vermillion Unit Resource Analyses - Vegetation Section, Little Snake Resource Area. Craig District Office, 1974.

U.S. Bureau of Land Management. Williams Fork Unit Resource Analysis. Recreation Section, Little Snake Resource Area, Craig District Office, 1974.

U.S. Bureau of Mines. Analysis of Colorado Coals. Technical Paper 574, 1937.

U.S. Bureau of Reclamation. BLM-EMRIA, Taylor Creek Reclamation Study Site, Salt Lake City, 1975.

U.S. Department of Agriculture. "General Soil Map Colorado". Unpublished 1975.

U.S. Department of Agriculture. 1951 Soil Survey Manual, Handbook 18, 1951.

U.S. Department of Agriculture, Soil Conservation Service. 1960 Soil Classification, A Comprehensive System, 7th Approximation. Supplements issued in 1967, 1968, and 1973.

U.S. Department of Agriculture, Soil Conservation Source Staff. "Planting Guide for Difficult Sites of the Upper Colorado River Basin". Unpublished, 1975.

U.S. Department of Commerce, Bureau of the Census. Census of Population, 1950.

U.S. Department of Commerce, Bureau of the Census. Census of Population, 1960.

U.S. Department of Commerce, Bureau of the Census. Census of Population, 1970.

U.S. Department of Commerce, Bureau of Economic Analysis. Local Area Personal Income Series, 1974.

U.S. Department of Commerce, Bureau of Economic Analysis. 1972 OBERS Projections, 1974.

U.S. Department of Commerce, Bureau of Economic Analysis. Regional Economics Information System, 1974.

U.S. Department of Commerce, Climatological Data, Colorado, Annual Summary. National Oceanic and Atmospheric Administration, v. 78, No. 13, 1973.

U.S. Department of Commerce, Social and Economic Statistics Administration. Statistical Abstract of the United States. Ninety-Fifth Annual Edition, 1974.

U.S. Department of Health, Education and Welfare. Air Quality Criteria for Hydrocarbons, 1970.

U.S. Departments of Interior and Agriculture. Guidelines for Evaluating Wild, Scenic and Recreational River Areas Proposed for Inclusion in the National Wild and Scenic Rivers System under Section 2, Public Law 90-542. GPO 889-442, 1970.

U.S. Department of the Interior. Energy Alternatives and Their Related Impacts, 1973.

U.S. Department of the Interior. Final Environmental Statement for Oil and Gas Development in the Santa Barbara Channel, Outer Continental Shelf off California, 1975.

U.S. Environmental Protection Agency. Air Pollution Considerations in Residential Planning, v. I, EPA-450, 1974.

U.S. Environmental Protection Agency. Compilation of Air Pollutant Emissions Factors. Second Edition, AP-42, Office of Air and Water Programs, 1973.

U.S. Environmental Protection Agency 40CFR 51.12 (3), 1973.

U.S. Environmental Protection Agency. Federal Register, 36, 67, 6680, 1971.

U.S. Environmental Protection Agency. Federal Register, 39, 42510, 1974.

U.S. Environmental Protection Agency. Methods for Chemical Analysis of Water and Wastes. Cincinnati, Ohio: National Environmental Research Center, 1971.

U.S. Environmental Protection Agency. STORET, 1974.

U.S. Federal Energy Administration. Project Independence Blueprint, 1974.

U.S. Federal Power Commission. 1971 National Power Survey, 1972.

U.S. Forest Service. National Forest Landscape Management. F.1, USDA Handbook 434, 1973.

U.S. Forest Service. National Forest Landscape Management. v. 2, USDA Handbook 462, 1974.

U.S. Forest Service. National Forest News -- Fiftieth Anniversary of National Forest Wilderness, 1974.

U.S. Forest Service. Routt National Forest, Map-Brochure, 1973.

U.S. Forest Service. White River National Forest, Recreation Information Management System, 1967 and 1974.

U.S. National Park Service. "Dinosaur National Monument". Unpublished Fact Sheet and Map-Brochure, 1973.

U.S. National Park Service. "Dinosaur National Monument". Unpublished Recreational Facility Report, 1975.

U.S. National Park Service. "Dinosaur National Monument". Unpublished Visitor-Use Information, 1969-1974.

U.S. National Park Service. Dinosaur National Monument Wilderness Study, 1973.

U.S. Office of Emergency Preparedness. *The Potential for Energy Conservation*, 1972.

U.S. Office of Management and Budget. *The 1974 Catalog of Federal Domestic Assistance*, 1974.

U.S. Public Health Service. *Drinking Water Standards, Revised*. U.S. Public Health Service Publication 956, 1962.

U.S. Soil Conservation Service. *National Association of Conservation Districts -- Inventory of Private Recreation Facilities; Steamboat Springs, Craig and Meeker Districts*, 1974.

Vogenthaler, T. J. *Analysis of Water Availability for Energy Development*. Colorado Energy Research Institute, 1975, p. 8.

VTN. *Draft Environmental Impact Analysis for the Proposed Colowyo Mine of Colowyo Coal Company, W. R. Grace and Company*. Denver, 1975.

VTN. *Modified Mining Plan, Colowyo Coal Mine - Axial, Colorado, Federal Coal Lease D-034365*. Denver, 1975.

VTN. *1975 Socioeconomic and Environmental Land Use Survey -- Summary*. Prepared for W. R. Grace and Company, 1975.

Wenger, G. R. *An Archeological Survey of Southern Blue Mountain and Douglas Creek in Northwestern Colorado*. University of Denver, Master's Thesis, 1956.

Wentz, D. A. *Effect of Mine Drainage on the Quality of Streams in Colorado, 1971-72*; U.S. Geological survey: Colorado Water Resources Circular 21, 1974.

Woodbury, A. M. "Distribution of Pigmy Conifers in Utah and Northwestern Arizona", *Ecology* 28: 1947, pp. 113-126.

Young, E. J., and Segerstrom, K. *A Disseminated Silver-Lead-Zinc Occurrence at Hahns Peak, Routt County, Colorado*. U.S. Geological Survey Bulletin 1367, 1973.

Zoller, W. H., Gladney, E. S., Gordon, G. E., and Bors, J. J. "Emissions of Trace Elements from Coal Fired Power Plants", *Trace Substance in Environmental Health*, v. VIII, 1974.

Appendix C
Glossary

GLOSSARY

Accipiter. Members of the Subfamily Accipitrinae of the Order Falconiformes; includes the goshawk, Coopers hawk and sharp-shinned hawk.

Acre-foot. A unit for measuring volume, equal to the quantity of water or other material required to cover one acre to a depth of one foot or a volume of 43,560 cubic feet.

Activity day. Participation in an outdoor recreation activity by one user for any period of a day.

Alkali soil. (1) A soil with a high degree of alkalinity (pH of 8.5 or higher), or with a high exchangeable sodium content (15 percent or more of the exchange capacity), or both. (2) A soil that contains sufficient alkali (sodium) to interfere with the growth of most crop plants.

Alluvial fan. A low, outspread, relatively flat to gently sloping mass of loose rock material, shaped like an open fan or a segment of a cone, deposited by a stream at the place where it issues from a narrow valley upon a plain or broad valley.

Alluvial soils. An azonal great soil group developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the original material by soil-forming processes.

Alluvium. Clay, silt, sand, and gravel or other rock material transported by flowing water, and deposited as sorted or semi-sorted sediments.

Ammonite. A marine animal with a shell that has a complex suture pattern.

Animal unit month. Pounds of forage or feed required to sustain one animal unit (e.g., 1 cow or 5 sheep) for a period of 30 days. (Abbreviated: AUM; Plural: AUMs).

Annual plant. A plant that completes its life cycle and dies in one year or less.

Anthracite. Coal of the highest metamorphic rank, in which fixed-carbon content is between 92% and 98%. It is hard, black, and has a semi-metallic luster and semi-conchoidal fracture.

Anticline. A fold, the core of which contains the stratigraphically older rocks; it is convex upward.

Archeological excavation. In a salvage situation in which sites will be destroyed as a result of construction, excavation is often the only means of information salvage. Sites are selected for excavation on the basis of a survey. The intent is to select a representative sample of every type of site from every time period. The sites so selected typically range from 5-10 percent of the sites located in the survey. All excavated materials are subjected to intensive laboratory analysis, description, and publication. By definition it is in itself a destructive activity, as the in-place value of the resource is destroyed through excavation.

Archeological inventory. An inventory is an attempt to locate every site within a specified region, or in the case of a right-of-way, every site along the right-of-way. The inventory requires covering the surface on foot, horseback, or vehicle, in transect intervals of 100 yards or less. An inventory produces as the end product an itemized description of each site, its location on a suitable detailed map, a photograph, and a collection of artifacts from the surface of each site.

Archeological literature search. An examination of published reports, manuscripts, and site survey files to determine site types and cultures present within an area. Occasionally it is possible to estimate site density and site situations utilized. Such a search is useful for the preparation of an environmental assessment and field study plans.

Archeological reconnaissance. A cursory examination of a region to locate actual sites as a means of determining site situations utilized and site types present. Normally such a study is conducted according to some sampling design.

Archeological resources. Objects and areas made or modified by man and the data associated with these artifacts and features. These resources rest in or on the ground.

Archeological survey. A survey is an extension of an inventory. In addition to site location the site collections are analyzed and each site is assigned to a culture period or periods. The analysis includes laboratory study of artifacts: cleaning, labelling, typological analysis, etc. If acquired, any datable samples are submitted for dating. The site types and artifacts are described in a published report which synthesizes all of the known archeological data in the region studied.

Arkosic sandstone. A sandstone with considerable feldspar.

Artesian. Is synonymous with confined. Artesian water and artesian water body are equivalent respectively to confined ground water and confined water body.

Artesian well. Is a well deriving its water from an artesian or confined water body. The water level in an artesian well stands above the top of the artesian water body it taps.

Artifact. A material object made or modified in whole or in part by man. Among the most common artifacts or archeological sites are stone tools, chips, projectile points, and similar lithic debris.

Asymmetric fold. A fold, the limbs of which have different angles of dip relative to the axial surface, which is not vertical.

Autecology. Deals with the study of individual organisms or an individual species.

Available water-holding capacity (soils). The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil.

Average annual precipitation. An average of the yearly precipitation usually expressed in inches of water that fall or are computed to fall at a point or on an area during a specified number of calendar or water years.

Axis. (fold) In a fold, a line that connects the central points of each constituent stratum, from which its limbs bend; in a syncline, it is the trough, and in an anticline it is the crest.

Backfill. The process of filling, or the material used to fill, a surface mine pit.

Background. That portion of the visual landscape lying from the middleground limits to infinity. Color and texture are subdued in these landscapes, which are concerned with the two-dimensional shape of landforms against the sky.

Badlands. Extremely rough, high, narrowly and steeply gullied topography in arid or semiarid areas that are horizontally bedded and have a dry, loose soil.

Ballast. Rough, unscreened gravel, sand, and broken stone used as foundation for roads, especially that laid in the roadbed of a railroad to provide a firm surface for the track, to hold the track line, and to facilitate drainage.

Base flow. Sustained or fair-weather streamflow. In most streams, base flow is composed largely of ground water effluent.

Baseline data. Information collected prior to the initiation of an environmental analysis which forms a basis for the determination of environmental impacts.

Bed. A subdivision of a stratified sequence of rocks, lower in rank than a member or formation, internally composed of relatively homogeneous material exhibiting some degree of lithologic unity, and separated from the rocks above and below by visually or physically more or less well-defined boundary planes; "the smallest rock-stratigraphic unit recognized in classification."

Bedrock. The more or less solid rock in place either on or beneath the surface of the earth.

Belt conveyor. A moving, endless belt that rides on rollers and on which materials can be carried for various distances.

Beneficiation. Improvement of coal quality by separating out low quality material (by use of air or water).

Benthic. Bottom-dwelling.

Biochemical oxygen demand (BOD). The measure of the relative oxygen requirements of municipal and industrial wastewaters.

Biomass. Living weight.

Biomes. The major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions.

Boxcut. The initial pit in a strip mine where no open side exists; this results in a highwall on both sides of the pit.

Brachiopod. A bivalved marine invertebrate.

Breaks. Rough, broken topography--in many places the transition area between highlands and lowlands.

Browse. The part of leaf and twig growth of shrubs, woody vines, and trees available for animal consumption.

Btu. Abbreviation for the British thermal unit. Amount of heat needed to raise 1 pound of water 1 degree F (252 calories).

Buteo. Members of the Subfamily Buteoninae of the Order Falconiformes; includes eagles and broadwinged hawks, such as the red-tailed hawk, Swainsons hawk, rough-legged hawk, and ferruginous hawk.

Calcareous rock. A sedimentary rock containing an appreciable amount of calcium carbonate.

Carbonaceous. Said of a rock or sediment that is rich in carbon; coaly.

Carnivore. Flesh eater.

Carrion. The decaying flesh of a dead body.

Carrying capacity. The uppermost limit of a specific area's ability to support a given population.

Cephalopod. A marine invertebrate with a well-defined head and tentacles around the mouth (includes squid and the pearly Nautilus.)

Channery. Soil mass containing between 15 and 90 percent by volume of fragments.

Characteristic Landscape. The overall visual impression resulting from the combination of topography, vegetation, water resources, and cultural features that can be described in terms of the visual dominance elements.

Chemical Quality of Water. A term that embodies all the chemical and physical properties or attributes of water which are imparted to the water by the amounts and kinds of chemical constituents in colloidal suspension or dissolved in the water.

Chemical-quality station. A particular site on a stream, canal, lake, or reservoir where water samples are collected on a systematic basis for chemical study.

Chert. An impure flint (cryptocrystalline quartz), usually brown or grey-black, used for chipped stone implements.

Clastic. Pertaining to or being a rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals, and that have been transported individually for some distance from their places of origin; also said of the texture of such a rock.

Coal. A solid, brittle, dark brown to black, combustible, carbonaceous rock formed by the partial to complete decomposition of vegetation.

Colluvium. Loose, unconsolidated clay, silt, sand, and gravel at the foot of a slope, brought there by force of gravity.

Color. The property of reflecting light of a particular wavelength; dust or moisture-laden air fades its intensity in the middleground, and to a greater extent in the background.

Community. An aggregate of organisms which form a distinct ecological unit. Such a unit may be defined in terms of plants, animals, or both.

Concentration. A term used to describe the amounts of a material or substance in relation to the total mixture. In this report concentration is expressed in parts per million and in equivalents per million.

Concretion. A hard, compact, rounded, normally subspherical (but commonly very oblate or disk-shaped, and sometimes of irregular form with odd or fantastic outlines) mass or aggregate of mineral matter generally formed by orderly and localized precipitation from aqueous solution.

Conglomerate. A coarse-grained, clastic sedimentary rock composed of rounded (to subangular) fragments larger than 2 mm in diameter (granules, pebbles, cobbles, boulders) set in a fine-grained matrix of sand, silt, or any of the common natural cementing materials; the consolidated equivalent of gravel both in size range and in the essential roundness and sorting of its constituent particles.

Consequent stream. A stream that originates on a newly exposed or recently formed surface and that flows along a course determined entirely by the initial slope and configuration of that surface; a stream whose direction of flow is directly related to and a necessary consequence of the original dip-slope surface of the land and the geologic structure of the area.

Consumptive use. The quantity of water discharged to the atmosphere or incorporated in the products of the process in connection with domestic use, vegetative growth, food processing, or an industrial process.

Continental Deposit. A sedimentary deposit laid down on land (whether a true continent or only an island) or in bodies of water (whether fresh or saline), not directly connected with the ocean, as opposed to a marine deposit.

Contour furrows. Furrows plowed approximately on the contour on pasture or rangeland to prevent soil loss and increase infiltration. Also, furrows laid out approximately on the contour for irrigation purposes.

Crustacean. A class of invertebrates that usually live in water and breathe through gills; they have a hard outer shell and jointed appendages and bodies.

Cubic feet per second (cfs). A unit expressing rates of discharge, equal to the discharge through a rectangular cross section, one foot wide and one foot deep, flowing at an average velocity of one foot per second.

Cuesta. A hill or ridge with a gentle slope on one side and a steep slope on the other; specifically an asymmetric ridge with one face (dip slope) long and gentle and conforming with the dip of the resistant bed or beds that form it, and the opposite face (scarp slope) steep or even cliff-like and formed by the outcrop of the resistant rocks, the formation of the ridge being controlled by the differential erosion of the gently inclined strata. If the beds dip more than about 20°, such a ridge would be termed a hogback rather than cuesta.

Cultural resources. Objects, structures, sites, and districts that pertain to native peoples, or other communities; they are generally classified as historic and prehistoric (often referred to as archeologic). Such areas are important because of their educational, interpretive, and scientific value, because they are vital to the preservation of a subculture, or because they are representative examples.

Debris slide. A landslide involving a slow-to-rapid downslope movement of comparatively dry and predominantly unconsolidated and incoherent earth, soil, and debris in which the mass does not show backward rotation (as in a slump) but slides or rolls forward.

Degradation. The wearing down or away, and the general lowering or reduction of the Earth's surface by the natural processes of weathering and erosion.

Detrital. Pertaining to or formed from detritus; said especially of rocks, minerals, and sediments.

Detritus. A collective term for loose rock and mineral material that is worn off or removed directly by mechanical means, as by disintegration or abrasion; especially fragmental material, such as sand, silt, and clay, derived from older rocks and moved from its place of origin.

Diatoms. Microscopic plants in an aquatic ecosystem.

Dip. The angle that a structural surface, e.g., a bedding or fault plane, makes with the horizontal, measured perpendicular to the strike of the structure.

Dip slope. A slope of the land surface, roughly determined by and approximately conforming with the direction and the angle of dip of the underlying rocks; specifically the long, gently inclined face of a cuesta.

Direct runoff. The water from rainfall or melting snow that enters the stream system rapidly either as overland flow or as subsurface flow that does not reach the zone of saturation, and whose time spent underground is so brief that its rate of movement into the stream is almost as rapid as overland flow.

Discharge. The process by which water moves from an aquifer, or the amount of water that moves from an aquifer.

Dissolved solids. Solids that originate mostly from rocks and are in solution. Some colloidal material is treated as if it were in solution in determining dissolved solids. The total dissolved mineral constituents of water.

Dissolved-solids discharge. (1) the rate at which dry weight of dissolved solids passes a section of a stream or other conveyance channel, or (2) the quantity of dissolved solids, measured by dry weight or by volume, that is discharged in a given time.

Dissolved-solids yield. A unit for expressing the discharge of dissolved solids or sediment from an area. Sediment yield and dissolved-solids yield is usually given in tons per square mile per year.

Dissolved oxygen (DO). A measure of the oxygen content of a volume of water.

Dome. (fold) An uplift or anticlinal-type structure, either circular or elliptical in outline, in which the rock dips gently away in all directions.

Down dip. A direction that is downwards and parallel to the dip of a structure or surface.

Dragline. A type of excavating equipment which casts a rope-hung bucket and collects dug material by pulling the bucket with a second rope.

Dry farming. Farming without irrigation.

Ecology. The study of the relation of organisms or groups of organisms to their environment; animals and plants in their relation to each other.

Ecosystem. Complex self-sustaining natural system which includes living and nonliving components of the environment and the interactions that bind them together. Its functioning involves the circulation of matter and energy between organisms and their environment.

Eolian soil material. Soil material accumulated through wind action.

Erodible. Susceptible to erosion. (Expressed by terms such as highly erodible, slightly erodible, etc.)

Erosion surface. A land surface shaped and subdued by the action of erosion, especially by running water. The term is generally applied to a level or nearly level surface.

Escarpment. A long, more or less continuous cliff or relatively steep slope facing in one general direction breaking the general continuity of the land by separating two level or gently sloping surfaces, and produced by erosion or by faulting.

Evaporation. The process by which water is changed from the liquid or solid state into the vapor state.

Evapotranspiration. The process by which water is withdrawn from a land area by evaporation from water surfaces and moist soil and by plant transpiration.

Exotics. An imported floral or faunal species, non-native.

Fault. A surface or zone of rock fracture along which there has been displacement, from a few centimeters to a few kilometers in scale.

Fauna. All animals of a particular period or region, taken collectively.

Fecal coliform. A type of bacteria found in the waste excretions of warm-blooded animals used as the prime indicator of organic fecal pollution.

Feldspar. A group of abundant rock-forming minerals of general formula: $MAl(Al,Si)_3O_8$, where M = K, Na, Ca, Ba, Rb, Sr, and Fe. Feldspars are the most widespread of any mineral group and constitute 60% of the earth's crust; they occur as components of all kinds of rock.

Flora. All plant life of a particular period or region.

Fluviatile deposits. Sedimentary deposits laid down by a river or stream.

Food chain. The pattern of energy or food transfer between a series of organisms interrelated in their feeding habits within an ecosystem. One organism is fed upon by another which in turn is fed upon by another, etc.

Food web. The combination of two or more interconnected food chains.

Forb. Any herbaceous plant other than those that are grass or grass-like.

Foreground. That portion of the visual landscape lying generally from one-quarter to one mile beyond the viewer. Details of human-size features are visible at this distance, and all features are large-scale elements.

Form. The three-dimensional shape of an object or a collection of objects that appear as one.

Formation. A distinctive bed or sequence of rocks selected as a convenient unit for mapping, description, and reference.

Fossil. Any remains, trace, or imprint of a plant or animal that has been preserved by natural processes, in the Earth's crust, since some past geologic time; any evidence of past life.

Fossiliferous. Containing fossilized material.

Frangible. Readily or easily broken.

Friable. Easy to break, crumbling naturally, poorly cemented so as to crumble.

Gaging station. A particular site on a stream, canal, lake, or reservoir where systematic observations of gage height or water discharge are obtained. A streamflow gaging station is a gaging station on a stream.

Gallons per minute (gpm). A unit expressing rates of discharge. One cubic foot per second is equal to 448.8 gpm or 646,272 gpd (gallons per day).

Gastropod. Terrestrial or aquatic invertebrate, typically possessing a calcareous, coiled shell, i.e., snail.

Geomorphic. Pertaining to the form of the earth or of its surface features.

Geomorphology. The science that treats the general configuration of the earth's surface; specifically the study of the classification description, nature, origin, and development of present landforms and their relationships to underlying structures, and of the history of geologic changes as recorded by these surface features.

gpd. Gallons per day.

gpm. Gallons per minute.

Graben. An elongate, relatively depressed crustal unit or block that is bounded by faults on its long sides. It is a structural form that may or may not be geomorphologically expressed as a rift valley.

Grade. A degree of inclination, or a rate of ascent or descent, with respect to the horizontal, or a road, railroad, embankment, conduit, or other engineering structure; it is expressed as a ratio (vertical to horizontal), a fraction (such as m/km or ft/mi), or a percentage (of horizontal distance).

Ground water. That part of subsurface water that completely saturates the rocks and is under hydrostatic pressure.

Ground water confined. Confined ground water is under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.

Ground water, perched. Perched ground water is unconfined ground water separated from an underlying body of ground water by an unsaturated zone. Its water table is a perched water table. It is held up by a perching bed whose permeability is so low that water percolating downward through it is not able to bring water in the underlying unsaturated zone above atmospheric pressure. Perched ground water may be either permanent, where recharge is frequent enough to maintain a saturated zone above the perching bed, or temporary, where intermittent recharge is not great or frequent enough to prevent the perched water from disappearing from time to time as a result of drainage over the edge of or through the perching bed.

Ground water, unconfined. Unconfined ground water is water in an aquifer that has a water table.

Habitat. A specific set of physical conditions that surround the single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

Herbivore. Feeds on vegetation.

Herpetofauna. The reptile and amphibian portion of the region's fauna.

Heterotrophic. Obtains food from organic material.

Highwall. The unexcavated face of exposed overburden and coal in a strip mine pit.

Historic site. Any place associated with a significant event, an important person, or a cultural activity of the past. Historic in most cases is 50 years old or older, except for rare instances where exceptional events have taken place, such as the site of the first atom bomb detonation.

Hydrograph. A graph showing stage, flow, velocity, or other property of water with respect to time.

Hardness. A property of water which has generally been associated with the effects observed in the use of soap, or with the deposit left by some types of water when they are heated. Hardness, expressed in terms of an equivalent quantity of calcium carbonate ($CaCO_3$), is calculated from the equivalence of calcium and magnesium, or is determined by direct titration. Hardness caused by calcium and magnesium (and other ions if significant) equivalent to the carbonate and bicarbonate is called carbonate hardness; the hardness in excess of this quantity is called noncarbonate hardness.

Insectivore. Feeds on insects.

In situ. A Latin phrase meaning "in place". Archeologically it refers to an artifact or object found in its original undisturbed position.

Intermittent stream. One which flows part of the time, as after a rainstorm, or during part of the year.

Interspecific tolerance. The degree of tolerance towards members of other species.

Intraspecific tolerance. The degree of tolerance towards others of the same species.

Invertebrate. An animal without a backbone or spinal column.

Ion. An electrified particle formed when a neutral atom or group of atoms loses or gains one or more electrons. If electrons are lost, the particle is positively charged and is called a cation. If electrons are gained, the particle is negatively charged and is called an anion. When a molecule goes into solution, it breaks down into one or more cations and one or more anions. For example, a molecule of the mineral gypsum or calcium sulfate ($CaSO_4$) when dissolved in water disassociates into a calcium ion (Ca^{++}) and a sulfate ion (SO_4^{--}).

Irrigation. The controlled application of water to arable lands to supply water requirements not satisfied by rainfall.

Isopach. A line connecting points of equal or corresponding thickness.

Isopleth. A line connecting points of equal or corresponding values with regard to certain chemical elements.

Jackson Turbidity Unit (JTU). Unit used to measure the turbidity or amount of suspended particulate material carried by a stream.

Joint. A surface of actual or potential fracture or parting in a rock, without displacement; the surface is usually plane and often occurs with parallel joints to form part of a joint set.

Lacustrine. Pertaining to, produced by, or formed in a lake or lakes.

Lagomorph. The taxonomic group of animals that include rabbits, hares, and pikas.

Lake. Any lentic (standing) body of water (e.g., reservoir, pond).

Landform. A discernible natural landscape, such as a floodplain, stream terrace, plateau, valley, etc.

Landscape Visual Unit. Smaller land units into which viewsheds are divided. These distinct now-overlapping units are areas that have differing degrees of visual exposure relative to the viewer. They are defined according to their distance (foreground, middleground, and background) from the viewer, the directions(s) of travel along roads from which they may be viewed, and according to the unique combinations of viewshed sequences providing the view(s).

Landslide. A general term covering a wide variety of mass movement landforms and processes involving the moderately rapid to rapid (on the order of one foot per year or greater) downslope transport, by means of gravitational body stresses of soil and rock material en masse. Usually, but not always, the displaced material moves over a relatively confined zone or surface of shear. The wide range in site variables, structure, and in the material properties affecting resistance to shear, as well as in the factors affecting the driving forces, results in a great range in landslide morphology, rates, and patterns of movement, and in scale. Landsliding is usually preceded, accompanied by, and followed by perceptible creep deformation, along the surface of sliding and/or within the slide mass. Terminology designating particular landslide types generally refers to the landform as well as the process responsible for the landform, e.g., rockfall, talus, translational slide, rockslide, block slide, debris slide, avalanche, earthflow, mudflow, quick clay slide, liquefaction slide, slump, rotational slide, etc.

Leach. To dissolve out by the action of a percolating liquid.

Lentic. Relating to a standing body of water (e.g., ponds, lakes).

Lignite. A brownish-black coal that is intermediate in coalification between peat and subbituminous coal; consolidated coal with a calorific value less than 8300 Btu/pound, on a moist, mineral-matter-free basis.

Limiting factor. A critical living or nonliving element of an ecosystem necessary for an organism to survive that is in the least supply.

Line. Anything arranged in a row or sequence, the silhouette of a form(s), a largely uni-dimensional form, or the intersection of two planes.

Lithic Debris. Cultural material made of stone.

Loess. A widespread, homogeneous, commonly nonstratified, porous, friable, unconsolidated but slightly coherent, usually highly calcareous, fine-grained, blanket deposit of marl or loam, consisting predominantly of silt with subordinate grain sizes ranging from clay to fine sand. Although source and origin is still a controversial question, loess is now generally believed to be windblown dust.

Long ton. A unit of weight that equals 2,240 pounds.

Lotic. Relating to a flowing body of water (e.g., rivers, brooks).

Low, medium, and high flows. Arbitrary designations based on the percentage of time a water discharge was equaled or exceeded. High flows are those greater than a discharge that was equaled or exceeded 20 percent of the time; low flows are those less than a discharge that was equaled or exceeded 80 percent of the time; and medium flows are those greater than a discharge equaled or exceeded 80 percent of the time, but less than a discharge equalled or exceeded 20 percent of the time.

Macrohabitat. General habitat values that are shared by all species of the same order, family, or genus.

Macroinvertebrates. Organisms lacking a spinal cord which inhabit the bottoms of aquatic environments.

Mano. The upper stone used on a metate to grind grains.

Marine. Of, or belonging to, or caused by the sea.

Mesophyte. A plant that grows under intermediate moisture conditions.

Metate. The lower part of a milling stone used to grind grains.

Mg/l. Abbreviation for milligrams per liter, the unit of expression for the concentration of dissolved minerals in water.

Middleground. That portion of the visual landscape lying generally from the limits of foreground to eight miles beyond the viewer. Overall patterns of vegetation and earthform constitute texture which is no longer distinguishable in human-size features.

Minus Deviations. Changes in the natural landscape that do not borrow dominance elements from the characteristic landscape.

Miscellaneous land type. Areas of land that have little or no natural soil or that are too nearly inaccessible for orderly examination, or that occur where for other reasons it is not feasible to classify the soil.

Mollusk. A group of invertebrates that are unjointed and generally enclosed in a shell; such as snails, clams, chitins, and others.

Monocline. A unit of strata that dips or flexes from the horizontal in one direction only, and is not part of an anticline or syncline. It is generally a large feature of gentle dip.

Morainal deposit. An accumulation of unsorted, unstratified, glacial drift.

Mudstone. An indurated mud having the texture and composition, but lacking the fine lamination or fissility, of shale.

Mustelid. Furbearing mammals of the family Mustelifae, such as skunks, weasels, etc.

National Register of Historic Places. A listing maintained by the National Park Service of architectural, historical, archeological, and cultural sites of local, State, or national significance.

Niche. A faunal species function within the ecosystem.

Normal fault. A fault in which the hanging wall appears to have moved downward relative to the footwall. The angle of the fault is usually 45-90°.

Ocher. An iron rich clay, ranging in color from yellow to brown, used as a pigment.

Omnivore. A nonselective feeder, feeds on both plant and animal material.

Overburden. All the earth and other materials which lie above a natural deposit of minerals.

Oxbow lake. The crescent-shaped, often ephemeral, body of standing water situated by the side of a stream in the abandoned channel (oxbow) of a meander after the stream formed a neck cutoff and the ends of the original bend were silted up.

Paleontology. The study of life in past geologic periods, based on fossil plants and animals and including phylogeny, their relationships to existing plants and animals, and the chronology of the earth's history.

Paludal. Pertaining to swamps or marshes, and to material deposited in a swamp environment.

Parts per million (ppm). A unit for expressing concentration of dissolved solids and sediment. A part per million of dissolved solids is a unit weight of dissolved solids in a million unit weights of a water-dissolved solids solution. A part per million of sediment is a unit weight of sediment in a million unit weights of water-sediment mixture.

Pelecypod. Bivalved aquatic invertebrate.

Percent sodium. The ration, expressed in percentage, of equivalents per million of sodium ions to the sum of equivalents per million of calcium, magnesium, sodium, and potassium ions.

Perennial stream. One which flows continuously from source to mouth during most years.

Permeability. (1) The quality of a soil horizon that enables water or air to move through it. (2) The property or capacity of a porous rock sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it.

(pH) Hydrogen-ion concentration. The negative logarithm of the concentration of hydrogen ions. The pH is a measure of the activity of the hydrogen ions and thus is a numerical value or measure of the alkalinity or acidity of the water. Ordinarily, water having a pH of 7.0 is regarded as neutral; a pH lower than 7.0 indicates acidic properties; and a pH higher than 7.0 indicates alkalinity. However, a water that is acid, alkaline, or neutral according to the pH scale is not necessarily the same by another standard.

Physical properties (of soils). Those characteristics, processes, or reactions of a soil which are caused by physical forces and which can be described by, or expressed in, physical terms or equations.

Plus Deviations. Changes in the natural landscape that borrow dominance elements from the characteristic landscape.

Porosity. The property of a rock, soil, or other material containing interstices. It is commonly expressed as a percentage of the bulk volume of material occupied by interstices, whether isolated or connected.

Precipitation. The discharge of water, in liquid or solid state, out of the atmosphere, generally upon land or water surface. The term is also used to designate the quantity of water that is precipitated.

Primary consumer. Heterotrophic organisms that feed directly on producers.

Producer. Autotrophic organisms, largely green plants, which are able to manufacture food from simple inorganic substances.

Protists. A group of unicellular organisms, such as bacteria and slime molds, which are often considered to form a third kingdom, distinct from the plant and animal kingdoms.

R. Range, one of the north-south rows of townships in a U.S. public-land survey.(Plural: Rs.)

Rainfall. The quantity of water that falls as rain only. The term is not synonymous with precipitation.

Range. The area occupied by a given species for all or a portion of their lives.

Raptor. Birds of prey with sharp talons and strong notched beaks: hawks, owls, vultures, etc.

Recharge. The process by which water moves into an aquifer, or the amount of water that moves into an aquifer.

Reclamation. The process of returning resource values to lands affected by controlled land disturbances to a form and productivity consistent with a stated land use plan which includes a stable ecological state, is compatible with the values of the surrounding lands, and is executed on lands which are fully capable of supporting the uses or higher or better uses which they were capable of supporting prior to disturbance.

Controlled land disturbance. Including mining, oil and gas recovery, access roads, powerlines, pipelines, and any other activities which alter the original ground surface and the resources (either surface or subsurface), and require prior approval by the regulatory authority.

Recreation Capability Classification. A rating of the land's natural capability to both attract and sustain recreational use, irrespective of location, present access, and potential management applications.

Rehabilitation. The process of returning resource values to lands affected by uncontrolled land disturbances to a form and productivity consistent with a stated land use plan which includes a stable ecological state.

Uncontrolled land disturbance. Includes fire, floods, landslides, earthquakes, or other types of disturbances arising from natural causes, catastrophic occurrences, or uncontrolled human activity, which usually results in the destruction or degradation of the resource values on the lands affected.

Reserves. Known deposits of coal that can be profitably mined. Tonnage generally known within 20 percent.

Residual material. Unconsolidated or partly weathered parent material of a soil, presumed to have developed in place (by weathering) from the consolidated rock on which it lies; it is the material from which soils are formed.

Residual sodium carbonate (RSC). The amount of carbonate plus bicarbonate, expressed in equivalents per million, that would remain in solution if all the calcium and magnesium were precipitated as carbonate.

$$RSC+(CO_3+HCO_3)-(Ca+Mg)$$

Resources. Includes reserves and other coal deposits that may become profitable to mine. Tonnage imperfectly known.

Restoration, soil. Returned to the original condition.

Return flow. The water returned to the stream system or source after being used. Return flow is generally equal to water use less consumptive use.

Riparian. Situated on or pertaining to the bank of a river, stream, or other body of water.

Riprap. A layer of large, durable, dense, specially selected and graded, broken rock fragments thrown together irregularly (as in deep water or on a soft bottom) to prevent erosion, through wave action or strong currents, and thereby preserve the shape of a surface, slope, or underlying structure. It is used for irrigation channels, river-improvement works, spillways at dams, and shore protection.

Rough broken land. Land with very steep topography and numerous intermittent drainage channels, but usually covered with vegetation.

Runoff. That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man, in or on the stream channels or on the drainage area.

Saline-alkali soil. A soil containing sufficient exchangeable sodium to interfere with the growth of most crop plants, and containing appreciable quantities of soluble salts.

Saline soil. A nonalkali soil containing sufficient soluble salts to impair its productivity but not containing excessive exchangeable sodium.

Sand. A rock fragment or detrital particle smaller than a granule and larger than a coarse silt grain, having a diameter in the range of 1/16 to 2 mm (62-2000 microns, or 0.0025-0.08 in., or 4 to -1 phi units.)

Sandstone. A medium-grained, clastic sedimentary rock composed of abundant and rounded or angular fragments of sand size set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material (commonly silica, iron oxide, or calcium carbonate); the consolidated equivalent of sand.

Saturated zone. That part of water-bearing material in which all voids, large and small, are filled with water under pressure greater than atmospheric.

Scarp. A line of cliffs or steep slopes produced by faulting or by erosion. The term is an abbreviated form of escarpment, and the two terms commonly have the same meaning, although "scarp" is more often applied to cliffs formed by faulting.

Scraper. A stone implement used to scrape leather, smooth wood, etc.

Sec. Section; a parcel of land that is one square mile or 640 acres. (Plural: Secs.)

Secondary consumer. Heterotrophic organisms that feed on other heterotrophs.

Sediment. Fragmented material that originates mostly from rocks and is transported by, suspended in, or deposited from water or air.

Sedimentation. The process by which the turbidity of a stream is increased by the passage of sediment.

Sediment discharge. (1) the rate at which dry weight of sediment passes a section of a stream, or (2) the quantity of sediment, as measured by dry weight or by volume, that is discharged in a given time.

Sediment station. A particular site on a stream, canal, or other waterway where a record of sediment discharge is obtained.

Sediment yield. A unit for expressing the discharge of dissolved solids or sediment from an area. Sediment yield and dissolved-solids yield is usually given in tons per square mile per year.

Semiarid. A term applied to regions or climates where moisture is normally greater than under arid conditions, but still definitely limits the growth of most crops.

Shale. A fine-grained, indurated, detrital sedimentary rock formed by the consolidation (as by compression or cementation) of clay, silt, or mud, and characterized by finely stratified (laminae 0.1-0.4 mm thick) structure and/or fissility that is approximately parallel to the bedding (along which the rock breaks readily into thin layers), and that is commonly most conspicuous on weathered surfaces, and by a composition with an appreciable content of clay minerals or derivatives from clay minerals, and with a high content of detrital quartz.

Sherd. A broken piece of a pottery vessel.

Short ton. A unit of weight that equals 2,000 pounds.

Sill. An intrusive body of igneous rock of approximately uniform thickness, and relatively thin compared with its lateral extent, which has been emplaced parallel to the bedding of the intruded rocks.

Silt. (soil) A soil-texture term used in the U.S. for a rock or mineral particle in the soil, having a diameter in the range of 0.02-0.05 mm; prior to 1937, the range was 0.005-0.05 mm. The diameter range recognized by the International Society of Soil Science is 0.002-0.02 mms.

Siltstone. An indurated or somewhat indurated silt having texture and composition, but lacking the fine lamination or fissility, of shale.

Slump. (1) Material that has slid down from high rock slopes. (2) The downward slipping of a mass of rock or unconsolidated material of any size, moving as a unit or as several subsidiary units, usually with backward rotation on a more or less horizontal axis parallel to the cliff or slope from which it descends.

Slurry. A mixture of fine coal in water. Commonly pumped through pipelines at processing plants or to consumption points.

Social Support Facilities. Those facilities necessary for the existence of a town such as schools, roads, medical services, and facilities normally supported by public funds.

Sodium-absorption-ratio (SAR). Related to the absorption of sodium by the soil and is an index of the sodium, or alkali, hazard of the water. In the computation of SAR, concentrations of constituents are in equivalents per million.

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Soil association. A mapping unit used on general soil maps in which two or more defined taxonomic units occurring together in a characteristic pattern are combined on the map into one unit. The components of the soil association may or may not be contrasting.

Soil material. Soils leached free of soluble salts and capable of sustaining plant growth, and recognized as such by standard authorities.

Soil series. A group of soils having horizons similar in characteristics and arrangement in the soil profile, except for texture of the surface portion.

Specific conductance. A measure of the capacity of a solution to conduct an electrical current, expressed in micromhos per centimeter at 25°C. It is one million times the reciprocal of specific resistance at 25°C. Specific resistance is the resistance in ohms of a column of water one centimeter long and one square centimeter in cross section. Because the specific conductance is related to the number and specific chemical types of ions in solution, it can be used for approximating the salinity of the water.

Spoil. The overburden removed in strip mining. Debris or waste material from a strip mine.

Stratigraphic trap. The sealing of a reservoir bed as the result of lithologic changes rather than through structural trapping conditions.

Stratigraphic unit. A stratum or body of strata recognized as a unit in the classification of the rocks of the earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

Stratigraphy. The branch of geology that deals with the definition and description of major and minor natural divisons of rocks (mainly sedimentary, but not excluding igneous and metamorphic) available for study in outcrop or from subsurface. It involves interpretation of these features of rock strata in terms of their origin, occurrence, environment, thickness, lithology, composition, fossil content, age, history, paleogeographic conditions, relation to organic evolution, and relation to other geologic concepts.

Stratum. A tabular or sheet-like mass, or a single and distinct layer, of homogeneous or gradational sedimentary material (consolidated rock or unconsolidated earth) of any thickness, visually separable from other layers above and below by a discrete change in the character of the material deposited, or by a sharp physical break in deposition, or by both; a sedimentary bed. (Plural: Strata.)

Stream. Any lotic (flowing) body of water (e.g., brooks, rivers).

Streamflow. The water discharge that occurs in a natural channel, whether or not the water discharge is affected by regulation or underflow.

Strike. The direction or trend that a structural surface, e.g. a bedding or fault plane, takes as it intersects the horizontal.

Structural trap. The containment of oil or gas within a reservoir bed as the result of flexure or fracture.

Subbituminous coal. Nonagglomerating coal having a heat value of 8,300 to 13,000 Btu on a moist, mineral-matter-free basis. Intermediate in rank between lignite and bituminous coal.

Succession. The progressive development of vegetation toward its highest ecological expression, the climax; replacement of one plant community by another.

Suspended sediment. Sediment that is supported by the upward components of turbulent currents, or by colloidal suspension if the sediment particles are very small.

Synecology. Deals with the study of groups of organisms which are associated together as a unit.

T. Township, a tract of land that is bounded on the east and west by meridians six miles apart at its south border, has a north-south length of six miles, and forms one of the chief divisions of a U.S. public-land survey. (Plural: Tps.)

Talus. (1) Talus slope. (2) Rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep, rocky slope.

Temperature inversion. A layer in which temperature increases with altitude. The principal characteristic of an inversion layer is its marked static stability, within which very little turbulent exchange can occur.

Terrace. Any long, narrow, relatively level or gently inclined surface, generally less broad than a plain, bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope.

Terrestrial. Consisting of or pertaining to the land in distinction from water.

Terrestrial deposit. (1) A sedimentary deposit laid down on land above tidal reach, as opposed to a marine deposit. (2) Strictly, a sedimentary deposit laid down on land as opposed to one resulting from the action of water.

Texture. The visual arrangement of the parts of a landscape feature. What constitutes texture depends on the object's distance from the viewer; the dominant texture of trees, for example, is leaves or boughs in the foreground, individual trees or groves in the middle-ground, and forests in the background.

Thrust fault. A fault with a dip of 45° or less in which the hanging wall appears to have moved upward relative to the footwall. Horizontal compression rather than vertical displacement is its characteristic feature.

Tons per day. A unit commonly used for expressing discharge of dissolved solids and sediment.

Tons per square mile per year. A unit for expressing the discharge of dissolved solids or sediment from an area. Sediment yield and dissolved-solids yield is usually given in tons per square mile per year.

Topsoil. Natural earth materials at or adjacent to the land surface, with physical and chemical characteristics necessary to support vegetation.

Total dissolved solids (TDS). The dissolved mineral constituents of water.

Transpiration. The process by which water moves from living plants to the atmosphere.

Trophic level. Energy level where those organisms with similar feeding habits are grouped together, as in an energy pyramid.

Turbidity. The measure of the degree of light penetration produced in water by materials suspended in the water.

Unit train. A train made up entirely of coal cars carrying coal directly from the loading place to point of delivery.

Upland. (1) The higher ground of a region, in contrast with a valley, plain, or other low-lying land, a plateau. (2) The elevated land above the low areas along a stream.

Use (water). The total quantity of water pumped, diverted, applied, or utilized for any purpose.

Vertebrate. An animal having a backbone or spinal column.

Viewshed. A land unit bounded by topographic features that define the limits of views from within the unit. Adjacent viewsheds may share common topographic boundaries, or they may overlap if portions are visible from more than the unit's one viewshed sequence.

Viewshed Sequence. A road segment contained by a viewshed; a new viewshed sequence begins when the road enters a new or overlapping viewshed.

Viewshed Sequence Points. The points on a road where one viewshed sequence ends and another begins.

Visitor day. Participation in an outdoor recreation activity by one user or a combination of users that is equivalent to one 12-hour recreation visit.

Visual Dominance Elements. The four "building blocks" of the visual landscape that can be used to describe what is seen: form, line, color, and texture.

Water discharge. The flow of a stream or canal, outflow from a basin, or flow of water from a pipe. Water discharge includes the sediment mixed with and solids dissolved in the water.

Water table. The water table is that surface in an unconfined water body at which the pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. In wells which penetrate to greater depths, the water level will stand above or below the water table if an upward or downward component of ground-water flow exists.

Water type. A term used to denote the predominate cations and anions in water. Whether certain cations (calcium, magnesium, sodium, and potassium), and certain anions (bicarbonate, sulfate, and chloride), predominate depends on the concentrations in equivalents per million and the relation of the concentration of the individual ions to each other. For example, if the concentration of sodium makes up most of the total cations, and the concentration of bicarbonate makes up most of the total anions, the water is classified as a sodium bicarbonate type. However, if the second most abundant cation or anion is more than half the most abundant cation or anion, and the third most abundant cation or anion is more than half the second, they are included in the water-type classification in order of magnitude. Examples of these more complex water types would be calcium magnesium bicarbonate, calcium magnesium bicarbonate sulfate, and sodium magnesium calcium chloride sulfate.

Water year. The 12-month period October 1 through September 30 of the following calendar year. The water year is designated by the calendar year in which it ends.

Water yield. The runoff from a drainage basin.

Weighted-average concentration. A discharge-weighted average that approximated the dissolved-solids concentration of water that would be found in a reservoir containing all the water passing a given station during a specified period after thorough mixing in the reservoir. The effects of evaporation, precipitation, or the addition or removal of dissolved constituents by plants or animals is not considered in this definition.

Wind rose. A diagram designed to show the distribution of wind direction recorded at a given location over a period of time.

Working pit. The place at a mine from which coal is actually being extracted.

Appendix D

TABLE OF CONTENTS

APPENDIX D

LEASE COPIES - SECTION I ▶

RECLAMATION - SECTION II ▶

GEOLOGIC AND GEOGRAPHIC SETTING - SECTION III ▶

COAL PRODUCTION - SECTION IV ▶

WATER RESOURCES - SECTION V ▶

AIR QUALITY - SECTION VI ▶

SOILS - SECTION VII ▶

TERRESTRIAL FAUNA - SECTION VIII ▶

AQUATIC BIOLOGY - SECTION IX ▶

RECREATION - SECTION X ▶

SOCIAL ENVIRONMENT AND ECONOMIC CONDITIONS - SECTION XI ▶

Lease Copies

APPENDIX D

TABLE OF CONTENTS
FOR
LEASES

Page

Energy Fuels Corporation Coal Leases---------------------------------- I-1
- C-081330-- I-2
- C-0128433--- I-8
- C-052547-- I-28

W. R. Grace and Company Coal Lease-- I-32
- D-034365-- I-33
- Right-of-Way-- I-37

Peabody Coal Company Coal Leases-- I-38
- C-081251-- I-39
- C-081258-- I-45
- C-0114093--- I-51

Ruby Construction Company, Inc. Coal Leases------------------------------- I-56
- D-051698-- I-57

APPENDIX D

TABLE OF CONTENTS
FOR
LEASES

Table	Title	Page
I-1	Preference Right Lease Applications in Study Region	I-61
I-2	Competitive Lease Applications in Study Region	I-62
I-3	Issued Preference Right Leases in Study Region	I-63
I-4	Issued Competitive Leases in Study Region	I-64

COAL LEASES C-081330
C-0128433
C-052547 (originally issued to
Thomas P. Greenhalgh)
OF
ENERGY FUELS CORPORATION

(Morgan Coal Company currently lessor of all three leases has appointed Energy Fuels Corporation the Designated Operator.)

FILE
JM

Form 4—696
(July 1963)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
910 - 15th St., Denver, Colorado
Preference-right COAL LEASE
Act of February 25, 1920 (41 Stat. 437), as amended

ORIGINAL
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
1963 NOV 12 PM 1

Land Office
Colorado

Serial Number
C-081330

This lease, entered into on **NOV 1 1963**, 19 , by the United States of America, the lessor, through the Bureau of Land Management, and

Morgan Coal Company
2850 North Meridian Street
Indianapolis, Indiana

the lessee, pursuant and subject to the terms and provisions of the Act of February 25, 1920 (41 Stat. 437), as amended, hereinafter referred to as the Act, and to all reasonable regulations of the Secretary of the Interior now in force which are made a part hereof,

WITNESSETH:

Sec. 1. *Rights of lessee.* The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in the following-described tracts of land, situated in the State of **Colorado**

21

T. 4 N., R. 86 W., 6th P.M.
Section 8: Lots 1,2,3, SE¼
Section 9: N½SW¼
Section 17: NE¼, NW¼SE¼, W½
Section 18: E½, Lot 8

F

T. 5 N., R. 86 W., 6th P.M.
Section 20: S½
Section 21: SW¼
Section 28: W½NW¼, E½SW¼
Section 29: NE¼
Section 33: W½NE¼, NE¼NW¼

containing **2175.28** acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

*** (See attached sheet)**

Sec. 2. In consideration of the foregoing, the lessee hereby agrees:

(a) *Bond.* To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all the provisions of the lease, and to increase the amount or furnish such other bond as may be required.

(b) *Rental.* To pay the lessor annually, in advance, for each acre or part thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents for the first year, 50 cents for the second, third, fourth, and fifth years, respectively, and $1 for the sixth and each succeeding year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

*(c) *Royalty.* To pay the lessor a royalty of cents
lessee shall pay a royalty, less rent, on such minimum amount
on every ton of 2,000 pounds of coal mined during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

(d) *Minimum production.* Beginning with the sixth year of the lease, except when operations are interrupted by strikes, the elements, or casualties not attributable to the lessee, or unless on application and showing made, operations shall be suspended when market conditions are such that the lessee cannot operate except at a loss or suspended for the other reasons specified in Section 39 of the Act, to mine coal each year and pay a royalty thereon to a value of $1 per acre or fraction thereof. Operations under this lease shall be continuous except in the circumstances described or unless the lessee shall pay a royalty, less rent, on such minimum amount of the leased deposits, for one year in advance, in which case operations may be suspended for that year.

Nov 26 '63 -

(e) *Payments.* To make rental payments to the Manager of the appropriate Land Office, except that when this lease becomes productive the rentals and royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey, with whom all reports concerning operations under the lease shall be filed. All remittances to the Manager of the Land Office shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) *Plats, reports, maps.* At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined during the quarter, the character and quality thereof, amount of its products and byproducts disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with the regulations in 30 CFR, Part 211.

(g) *Weights.* To determine accurately the weight or quantity and quality of all leased deposits mined, and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) *Inspection.* To permit at all reasonable times (1) inspection by any duly authorized officer of the Department, of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) *Assignment.* To file for approval in the appropriate Land Office within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect the first day of the month following its approval by the Bureau of Land Management, or if the assignee requests, the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the regulations, 43 CFR 193.25.

(j) *Nondiscrimination clauses.* In connection with the performance of work under this contract, the lessee agrees as follows:

(1) The lessee will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the lessee's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The lessee will comply with all provisions of Executive Order No. 10925 of March 6, 1961, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The lessee will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the lessee's noncompliance with the nondiscrimination clause of this contract or with any of the said rules, regulations, or orders, this lease may be canceled in whole or in part and the lessee may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The lessee will include the provisions of the foregoing paragraphs (1) through (6) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order No. 10925 of March 6, 1961, so that such provisions will be binding upon each subcontractor or vendor. The lessee will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the lessee becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the lessee may request the United States to enter into such litigation to protect the interests of the United States.

NOTE TO CONTRACTOR – (Additional requirement for subcontracts with the Department of the Interior) – In compliance with the Rules and Regulations (41 CFR, Section 60–1.3(a)) issued under Executive Order 10925 of March 6, 1961, the prime contractor is hereby bound and agrees to include in each subcontract which it shall make with a subcontractor or supplier paragraphs (1) through (7) of Section 301 of said Executive Order (as quoted above), unless exempted pursuant to the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity.

(k) *Land disposed of with coal deposits reserved to the United States.* If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the deposits of coal therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

(l) *Operations, wages, freedom of purchase.* To comply with the operating regulations (30 CFR, Part 211), to exercise reasonable diligence, skill, and care in the operations of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health or property, and of waste or damage to any water or mineral deposits; to fairly and justly weigh or measure the coal mined by each miner, to pay all wages due miners and employees, both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding eight hours in any one day for underground workers, except in cases of emergency; to employ no boy under the age of sixteen and no girl or woman,

(c) Royalty (continued). To pay the lessor a royalty of 15 cents on every ton of 2,000 pounds mined by underground methods and 17½ cents a ton for coal mined by stripping or surface auger methods during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

without regard to age, in any mine below the surface; unless the laws of the State otherwise provide, in which case the State laws control.

(m) *Taxes.* To pay when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(n) *Overriding royalties.* Not to create, by assignment or otherwise, an overriding royalty interest in excess of 50 percent of the rate of royalty first payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, excepting, that where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Bureau of Land Management, that he has made substantial investments for improvements on the land covered by the assignment.

(o) *Delivery of premises in case of forfeiture.* In case of forfeiture of this lease, to deliver up to the lessor in good order and condition the land leased, including all buildings, and underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit.

Sec. 3. The lessor expressly reserves:

(a) *Rights reserved.* The right to permit for joint or several use such easements or rights-of-way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) *Disposition of surface.* The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) *Monopoly and fair prices.* Full power and authority to promulgate and enforce all the provisions of Section 30 of the Act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) *Readjustment of terms.* The right reasonably to readjust and fix royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 20-year period, he will be deemed to have agreed to such terms.

(e) *Waiver of conditions.* The right to waive any breach of the conditions contained herein, except the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. *Relinquishment of lease.* Upon a satisfactory showing that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment *must* be filed in *duplicate* in the appropriate Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to make payment of all accrued rentals and royalties and to provide for the preservation of any mines or productive works or permanent improvements on the leased lands in accordance with the regulations and terms of the lease.

Sec. 5. *Protection of the surface, natural resources, and improvements.* The lessee agrees to take such reasonable steps as may be needed to prevent operations from unnecessarily: (1) Causing or contributing to soil erosion or damaging any forage and timber growth thereon; (2) polluting the waters of springs, streams, wells, or reservoirs; (3) damaging crops, including forage, timber, or improvements of a surface owner; or (4) damaging range improvements whether owned by the United States or by its grazing permittees or lessees; and upon any partial or total relinquishment or the cancellation or expiration of this lease, or at any other time prior thereto when required by the lessor and to the extent deemed necessary by the lessor, to fill any sump holes, ditches and other excavations, remove or cover all debris, and, so far as reasonably possible, restore the surface of the leased land to its former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to lands of the United States and improvements thereon.

Sec. 6. *Removal of equipment, etc., on termination of lease.* Upon termination of this lease, by surrender or forfeiture, the lessee shall have the privilege at any time within a period of 90 days thereafter of removing from the premises all machinery, equipment, tools and materials, except underground timbering placed by the lessee in or on the leased lands, which are necessary for the preservation of the mine. Any materials, tools, appliances, machinery, structures, and equipment, subject to removal as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions, but the lessee shall remove any or all of such property where so directed by the lessor.

Sec. 7. *Proceedings in case of default.* If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or default in the performance or observance of any of the provisions of this lease, and such default shall continue for a period of 30 days after service of written notice thereof by the lessor, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act (30 USC, Sec. 188). If the lessee fails to take prompt and necessary steps to prevent loss of damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necdssary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee. However, the lessee shall not be held responsible for delays or casualties occasioned by causes beyond the lessee's control.

Sec. 8. *Heirs and successors in interest.* Each obligation hereunder shall extend to, and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 9. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States, as amended (41 USC, Sec. 22), and Sections 431, 432, and 433, Title 18, U. S. C., relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

IN WITNESS WHEREOF:

THE UNITED STATES OF AMERICA

By Iola M Clark
(Signing Officer)

CHIEF, MINERAL ADJUDICATION SECTION
(Title)

[illegible] 4 196[illegible]
(Date)

WITNESSES TO SIGNATURE OF LESSEE

MORGAN COAL COMPANY

Millie E. Spears

By Eiteljorg
(Signature of Lessee)
Harrison Eiteljorg, Managing Partner

(Signature of Lessee)

(Signature of Lessee)

(If this lease is executed by a corporation, it must bear the corporate seal)

NONDISCRIMINATION IN EMPLOYMENT

THIS CONTRACT (LEASE, LICENSE, PERMIT) IS SUBJECT TO THE PROVISIONS OF SEC. 301 OF EXECUTIVE ORDER NO. 10925, A COPY OF WHICH IS ATTACHED.

GPO 835-357

C-081330
COAL

Form 4—1634
(April 1962)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

NONDISCRIMINATION IN EMPLOYMENT

In connection with the performance of work under this contract, the Contractor agrees as follows:

(1) The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Contracting Officer setting forth the provisions of this nondiscrimination clause.

(2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The Contractor will send to each labor union or representative of workers with which he has a collective-bargaining agreement or other contract or understanding, a notice, to be provided by the agency Contracting Officer, advising the said labor union or workers' representative of the Contractor's commitments under this nondiscrimination clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Contractor will comply with all provisions of Executive Order No. 10925 of March 6, 1961, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The Contractor will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the Contractor's noncompliance with the nondiscrimination clause of this contract or with any of the said rules, regulations, or orders, this contract may be canceled in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The Contractor will include the provisions of the foregoing paragraphs (1) through (6) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to section 303 of Executive Order No. 10925 of March 6, 1961, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

NOTE TO CONTRACTOR

Additional requirement for subcontracts with the Department of the Interior.

In compliance with the Rules and Regulations (41 CFR, section 60–1.3(a)) issued under Executive Order 10925 of March 6, 1961, the prime contractor is hereby bound and agrees to include in each subcontract which it shall make with a subcontractor or supplier paragraphs (1) through (7) of section 301 of said Executive Order (as quoted above), unless exempted pursuant to the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity.

GPO 855220

BLM 004

GPO 832077

C-0128433

PREFERENCE RIGHT COAL LEASE

This lease, entered into on June 1, 1975, by the United States of America, the Lessor, through the Bureau of Land Management, and

Morgan Coal Company
4567 Cold Spring Road
Indianapolis, Indiana 46208

, The Lessee, pursuant and subject to the terms and provisions of the act of February 25, 1920, 41 Stat. 437 as amended, 30 U.S.C. § § 181-263, and to all regulations (including, but not limited to, 30 CFR Part 211 and 43 CFR Parts 23 and 3500) of the Secretary of the Interior now or hereafter in force which are made a part hereof,

WITNESSETH:

Sec. 1. Rights of Lessee. The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth does hereby grant and lease to the Lessee the exclusive right and privilege to mine and dispose of all the Coal in the following-described tracts of land, situated in the State of Colorado:

T. 5 N., R. 86 W., 6th P.M. (Routt County)
Section 19: Lot 8, SE¼SW¼, S½SE½
Section 30: Lots 1, 2, 3, 4, E½W½

containing 474.93 acres, more or less, together with the right to construct all works, buildings, structures, and appliances as may be necessary and convenient for the mining and preparation of the Coal for market and, subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

Sec. 2. Definitions. (a) "Act" means the Mineral Leasing Act of February 25, 1920, 41 Stat. 437 as amended, 30 U.S.C. § § 181-263;

(b) "Anniversary Date" means the anniversary of the Effective Date of this lease;

(c) "Bureau" means the Bureau of Land Management;

(d) "Coal" means all ranks of coal from lignite to anthracite;

(e) "District Manager" means the manager of the district office or other authorized officer of the Bureau having administrative jurisdiction of or responsibility for the Leased Lands;

(f) "Effective Date" is June 1, 1975.

(g) "Geological Survey" means the United States Geological Survey;

(h) "Leased Lands" means the tracts described in section 1 of this Lease;

(i) "Lease Year" means the period of time between two successive Anniversary Dates of this Lease;

(j) "Lease Month" means the period of time between the day of any calendar month corresponding to the day of the month which is the Anniversary Date, and the same day of the first succeeding calendar month;

(k) "Mining Supervisor" means the area mining supervisor of the Conservation Division of the Geological Survey;

(l) "Ton" means a measure of weight of 2,000 pounds avoirdupois.

JUN 18 75

Sec. 3. Bond. The Lessee shall file with the appropriate Bureau office a $55,000 lease bond payable to the United States Department of the Interior, effective on the Effective Date, to insure payment of rentals and royalties on an annual basis, to insure compliance with the Environmental Stipulations incorporated into this Lease, and to insure compliance with all other terms of the Lease. An increase in the amount of the bond may be required by the Mining Supervisor upon approval of the exploration or mining plan required under sections 10 and 11 of this Lease, or upon approval of a change in either plan, or at any other time during the life of the Lease to reflect changed conditions. Notwithstanding anything contained in this section to the contrary, the Lessee may, in lieu of the bond herein described, post cash or negotiable United States Government Securities in the amount of the bond required, provided however that at all times the market value of said United States Government Securities, if posted, shall be at least equal to the sum of the bond required.

Sec. 4. Annual Advance Rental. (a) An annual rental, payable in advance, of $3.00 for each acre or fraction thereof covered by this Lease shall be due on the Effective Date and on each Anniversary Date hereafter. The rental shall be subject to section 39 of the Act (30 U.S.C. § 209), and for each year the rental shall be creditable against any production and advance royalties for that year as they accrue under this Lease.

Sec. 5. Production Royalty. (a) A production royalty of 8% of the gross value of coal produced; but not less than 40 cents per ton of 2,000 pounds, shall be due on coal extracted by the lessee from the leased lands.

(b) The Lessee agrees that the Lessor shall determine the gross value of the Coal produced from the Leased Lands for the purpose of Subsection 5(a) as follows:

(1) The gross value shall be considered to be the price received by the Lessee, adjusted for transportation and/or processing costs so that it is a measure of the value of the Coal at the mine mouth as designated or specified by the Area Mining Supervisor (or in the case of strip mining that point where the Coal is delivered from the pit): provided, that where it appears to the Lessor that a contract or other business arrangement between the Lessee and a purchaser of some or all of the Coal is not a bona fide transaction between independent parties, or where it appears to the Lessor that there is no price received for some or all of the Coal by the Lessee because the Lessee is consuming the Coal for his own use or adding it to inventories, the Lessor shall determine the value of such Coal produced by the Lessee by giving due consideration to: (A) the price received by the Lessee, (B) the highest price paid for a part or a majority of the production of Coal of like quality produced from the same general area during the Lease Month, (C) contracts or other business arrangements between Coal producers and customers for the sale of Coal, other than those involving sales of Coal produced under this Lease, which are comparable with respect to term, volume, time of execution, area of supply and other circumstances, and (D) other relevant factors.

(2) The Lessee agrees to supply any and all relevant information requested by the Lessor to aid in the decision as to whether the price received by the Lessee will be the gross value of the Coal produced. Such information shall include, but shall not be limited to, copies of contracts for the sale of Coal produced and evidence of legal relationships, if any, between the Lessee and his customers.

Sec. 6. Advance Royalty. (a) An advance royalty shall be due monthly at the rate set forth in subsection 5(a) based upon the following annual production rates: 10,100 Tons per Lease Month for the sixth Lease Year; 15,200 Tons per Lease Month for the seventh Lease Year: 20,200 Tons per Lease Month for the eighth Lease Year; 25,300 Tons per Lease Month for the ninth Lease Year; and 30,300 Tons per Lease Month for the tenth and each succeeding Lease Year.

(b) The Lessee agrees that the Lessor shall determine the gross value of Coal for the purpose of subsection 6(a) as follows:

(1) If during the Lease Month Coal is being produced from the Leased Lands, the gross value per Ton of the Coal for advance royalty purposes for that month shall be the weighted average of the gross value for such Coal for that month as determined for production royalty purposes under subsection 5(b).

(2) If during the Lease Month no Coal is produced from the Leased Lands, but in previous Lease Months Coal has been produced from the Leased Lands, the gross value per Ton of the Coal for advance royalty purposes shall be the weighted average of the gross value of the Coal produced in the most recent Lease Month in which Coal was produced from the Leased Lands as determined for production royalty purposes under subsection 5(b), raised or lowered in the same proportion as the Bureau of Labor Statistics Monthly Wholesale Price Index for bituminous coal has risen or fallen since the most recent Lease Month in which Coal was produced from the Leased Lands and the most recent month for which said price index has been published.

(3) If no Coal has ever been produced from the Leased Lands, the gross value of the Coal for advance royalty purposes in any Lease Month will be equal to $10.00 per ton, raised or lowered in the same proportion as the Bureau of Labor Statistics Monthly Wholesale Price Index for bituminous coal has risen or fallen between its level of 389.6 in May 1975 and its level in the most recent month for which said price index has been published.

(4) If for any reason in the judgment of the Lessor the Bureau of Labor Statistics Monthly Wholesale Price Index for bituminous coal becomes unavailable or inappropriate for the purpose of this subsection, the Lessee hereby agrees that the Lessor may, after consultation with the Lessee, substitute another index reasonably suited to the purpose of the subsection.

Sec. 7. Total Royalty Payments. (a) For any Lease Month, the total royalty payment, if any, shall be equal to the greater of:

(1) the excess of total advance royalty due from the Effective Date to and including the current Lease Month over the total royalty payments due (before the advance rental deduction) from the Effective Date to and including the Lease Month preceeding the current Lease Month, or

(2) the excess of total production royalty due from the Effective Date to and including the current Lease Month over the total royalty payments due (before the advance rental deduction) from the Effective Date to and including the Lease Month immediately preceding the current Lease Month less one-twelfth of the annual advance rental.

(b) For any Lease Month, the total royalty payment shall be payable by the final day of the third succeeding Lease Month.

(c) No refund and no credit, other than that against future production royalties, for advance royalty payments shall be made by lessor.

Sec. 8. Minimum Production. The Lessee shall produce Coal from the Leased lands in accordance with the mining plan required by section 11 of this Lease, except that the Mining Supervisor may suspend the production requirements in that plan when, in accordance with section 39 of the Act (30 U.S.C. § 209), he determines that it is in the interest of conservation, or when, in accordance with section 7 of the Act (30 U.S.C. § 207), the lessee files an application for suspension of the production requirements which shows to the satisfaction of the Mining Supervisor that operations are interrupted by strikes, the elements, or occurrences not attributable to the Lessee.

Sec. 9. Method of Payments. The Lessee shall make rental payments to the appropriate Bureau office until the first production or advance royalty payments are due. At that time, all rentals and production and advance royalties shall be paid to the Mining Supervisor with whom all reports concerning operations under the Lease shall be filed. All remittances to the Bureau shall be made payable to the Bureau of Land Management; those to the Geological Survey shall be made payable to the United States Geological Survey.

Sec. 10. Exploration Plan. (a) Prior to undertaking any exploratory work on the Leased Lands between the Effective Date and the date of approval of the mining plan required under section 11 of this Lease, the Lessee shall file with the Mining Supervisor an exploration plan in accordance with the provisions of 30 CFR Part 211 and 43 CFR Part 23, showing the exploratory work and reclamation measures following such work which he proposes, and he shall not commence that work until the Mining Supervisor has approved the exploration plan. After approval of the exploration plan, the Lessee shall conduct all exploratory work in accordance with the plan.

(b) Not less than 30 days after consulting with the Lessee, the Mining Supervisor may reasonably change or supplement the exploration plan at any time to be consistent with amended Environmental Stipulations or to adjust to changed conditions or to correct an oversight. If the Lessee seeks to obtain approval of a changed or supplemental plan, he shall submit a written statement of the proposed change or supplement and the justification for the proposed change or supplement. Within 30 days after receiving the written statement from the Lessee, the Mining Supervisor shall, in writing, approve or disapprove the proposed change or supplement, unless he shall advise the Lessee of compelling and valid reasons, requiring more than 30 days to make a decision. In no event shall proposed changes or supplements be effective unless the Mining Supervisor approves of them in writing.

(c) Exploratory work, as used in this section, shall include, but not be limited to, seismic work, drilling, blasting, research operations, cross-country travel, the construction of roads and trails and other necessary facilities required under the Environmental Stipulations incorporated in this Lease.

(d) The requirement under this section may be waived upon approval of the Mining Supervisor with concurrence of the District Manager, if the requirements of exploration have been met at the date of issuance of the lease.

Sec. 11. Mining Plan. (a) The Lessee shall file in sextuplicate with the Mining Supervisor on or before the third Anniversary Date a detailed development, production and reclamation plan in accordance with the provisions of 30 CFR Part 211 and 43 CFR Part 23. The plan is referred to in this Lease as the "mining plan". The plan shall include: (1) a schedule of further planning and exploratory operations, the development, production, processing, and reclamation operations and other activities to be conducted under this

Lease: (2) a detailed description of the procedures to be followed to assure that all operations will meet and conform with the Environmental Stipulations incorporated in the Lease; and (3) a showing that the Lessee will use all due diligence (A) to extract all Coal in the Leased Lands which can be safely recovered by approved mining methods consistent with the protection and use of other natural resources and with sound economic practice and (B) to attain production from the Leased Lands at a rate at least equal to the rate on which advance royalty for this Lease is computed.

(b) Prior to commencing any operations under the mining plan, the Lessee shall obtain the Mining Supervisor's approval of the plan. The Mining Supervisor shall not delay unnecessarily in the consideration of a plan, but he shall take time to consider both technical and environmental provisions of the plan thoroughly prior to approval. If the plan submitted by the Lessee is unacceptable, the Mining Supervisor shall inform the Lessee by written notice of the reasons why the plan is unacceptable and shall give him an opportunity to amend the plan. If an acceptable plan is not submitted to the Mining Supervisor by the Lessee within one year after the Lessee's receipt of the notice, the Mining Supervisor shall send a second written notice to the Lessee concerning the Lessee's failure to submit an acceptable plan. A failure by the Lessee to submit an acceptable plan within 60 days after his receipt of the second written notice without reasonable justification for delay shall be grounds for termination of the Lease, if the Lessor so elects.

(c) After the date of approval of the mining plan, the Lessee shall conduct all activities upon the Leased Lands in accordance with that plan, except for necessary activities for the disposition of property after termination of the Lease pursuant to section 27.

(d) Not less than 30 days after consulting with the Lessee, the Mining Supervisor may reasonably change or supplement the mining plan at any time to be consistent with amended Environmental Stipulations or to adjust to changed conditions or to correct an oversight. If the Lessee seeks to obtain approval of a changed or supplemental plan, he shall submit a written statement of the proposed change or supplement and the justification for the proposed change or supplement. Within 30 days after receiving the written statement from the Lessee, the Mining Supervisor shall, in writing, approve or disapprove the proposed change or supplement, unless he shall advise the Lessee of compelling and valid reasons for requiring more than 30 days to make a decision. In no event shall proposed changes or supplements be effective unless the Mining Supervisor approves of them in writing. Approval of the mining plan will be conditional and temporary to allow mining on an interim basis pending the completion of the Northwest Colorado Coal Environmental Impact Statement. Additional stipulations may be imposed or the mining plan otherwise modified after the completion of the Environmental Impact Statement.

(e) Within 30 days after the end of each calendar year (or if operations cease before the end of the calendar year, within 30 days after cessation of operation), the Lessee shall file with the Mining Supervisor a progress report describing the operations conducted under the mining plan.

Sec. 12. Operations on Leased Lands. (a) In accordance with the Environmental Stipulations incorporated in this Lease, the Lessee shall exercise reasonable diligence, skill, and care in all operations on the Leased Lands. The Lessee's obligations shall include, but not be limited to the following:

(1) The Lessee shall conduct all operations on the Leased Lands so as to avoid injury to life, health, or property;

(2) The Lessee shall avoid or, where avoidance is impracticable, minimize and, where practicable, correct hazards to the public health and safety resulting from his operations on the Leased Lands; and

(3) The Lessee shall minimize to the maximum extent possible

wasting of the mineral deposits and other resources, including but not limited to surface resources which may be found in, upon, or under such lands.

(b) In accordance with the Environmental Stipulations incorporated in this Lease, the Lessee shall take such reasonable steps, and shall conduct operations in such a manner as may be needed to avoid or, where avoidance is impracticable, to minimize and, where practicable, to repair damage to: (1) any forage and timber growth on Federal or non-Federal lands in the vicinity of the Leased Lands; (2) crops, including forage and timber, or improvements of a surface owner; or (3) improvements, whether owned by the United States or by its permittees, licensees, or lessees. The Lessor must approve the steps to be taken and the restoration to be made in the event of the occurrence of damage described in this subsection.

(c) The Lessee shall conduct all operations on the Leased Lands in accordance with the provisions of 30 CFR Part 211 and 43 CFR Part 23, whether they are surface or underground mining operations and whether they are in lands in which the Lessor owns the surface or those in which the Lessor has disposed of the surface.

(d) All water rights developed by Lessee through operations on the Leased Lands or other Federal lands in connection with the development of the Leased Lands shall immediately become the property of the Lessor. As long as the Lease continues, the Lessee shall have the right to use those water rights free of charge for activities under the Lease.

~~Sec. 13. Authorization of Other Uses and Disposition of Leased Lands.~~

~~(a) The Lessor reserves the right to authorize other uses of the Leased Lands by issuing, in addition to the Lease, leases, licenses, permits, easements or rights-of-way, including leases for the development of minerals other than Coal under the Act. The Lessor may authorize any other use that does not unreasonably interfere with the exploration and mining operations of the Lessee.~~

~~(b) The Lessor reserves the right (1) to sell or otherwise dispose of the surface of the Leased Lands under existing law or laws hereafter enacted insofar as said surface is not necessary for the use of the Lessee in the extraction and removal of the Coal therein, or (2) to dispose of any resource in such lands if such disposal will not unreasonably interfere with the exploration and mining operations of the Lessee.~~

eip
DRA
6/11/75

~~(c) If the Leased Lands have been or shall hereafter be disposed of under laws reserving to the United States the deposits of Coal therein, the Lessee shall comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such Coal.~~

~~(d) The Lessee shall make all reasonable efforts to avoid interference with other authorized uses of the Leased Lands.~~

~~(e) The District Manager may authorize the Lessee to charge persons engaged in other uses of the Leased Lands authorized by Lessor such fees as may be appropriate to compensate the Lessee for his expenditures, including loss of interest, to the extent that those expenditures benefit the other use.~~

Sec. 14. Equal Opportunity Clause. The Lessee agrees that during the performance of this contract:

(a) The Lessee will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising, layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Lessor setting forth the provisions of this Equal Opportunity Clause.

(b) The Lessee will, in all solicitations or advertisements for employees placed by or on behalf of the Lessee, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(c) The Lessee will send to each labor union or representative of workers with which the Lessee has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the Lessor, advising the labor union or workers' representative of the Lessee's commitments under this Equal Opportunity Clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(d) The Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(e) The Lessee will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, as amended, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by the Secretary of the Interior and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations and orders.

(f) In the event of the Lessee's noncompliance with the Equal Opportunity Clause of this Lease or with any of said rules, regulations or orders, this Lease may be cancelled, terminated or suspended in whole or in part and the Lessee may be declared ineligible for further Federal Government contracts or leases in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, as amended, and such other sanctions as may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(g) The Lessee will include the provisions of subsections (a) through (g) of this section in every contract, subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order No. 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each contractor, subcontractor, or subcontract, or purchase order as the Secretary of Labor may direct as a means of enforcing such provisions including sanctions for noncompliance; however, in the event the Lessee becomes involved in, or is threatened with, litigation with a contractor, subcontractor or vendor as a result of such direction by the Secretary of Labor, the Lessee may request the Lessor to enter into such litigation to protect the interests of the Lessor.

Sec. 15. Certification of Nonsegregated Facilities By entering into this Lease, the Lessee certifies that he does not and will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not and will not permit his employees to perform their services at any location under his control where segregated facilities are maintained. The Lessee agrees that a breach of this certification is a violation of the Equal Opportunity Clause of this Lease. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, rest rooms or wash rooms, restaurants or other eating areas, time clocks, locker rooms and other storage or dressing rooms, parking lots, drinking fountains, recreation or entertainment areas, transportation facilities and housing facilities provided for employees which are segregated by explicit directive, or are in fact segregated on the basis of race, color, religion, or natural origin because of habit, local custom, or otherwise. The Lessee further agrees that (except where he has obtained identical certifications from proposed contractors and subcontractors for specific time periods) he will obtain identical certifications from proposed contractors and subcontractors prior to the award of contracts or subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity Clause; that he will retain such certifications in his files; that he will forward the following certification to such proposed contractors and subcontractors (except where the proposed contractor or subcontractor has submitted identical certifications for specific time periods); and that he will notify prospective contractors and subcontractors of the requirement for certification of nonsegregated facilities. A Certification of Nonsegregated Facilities, as required by the May 9, 1967 Order (32 F.R. 7439, May 19, 1967) on Elimination of Segregated Facilities, by the Secretary of Labor, must be submitted prior to the award of a contract or subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity Clause. The certification may be submitted either for each contract and subcontract or for all contracts and subcontracts during a period (i.e. quarterly, semiannually, or annually).

Sec. 16. Employment Practices. The Lessee shall pay all wages due persons employed on the Leased Lands at least twice each month in lawful money of the United States. The Lessee shall grant all miners and other employees complete freedom to purchase goods and service of their own choice. The Lessee shall restrict the workday to not more than 8 hours in any one day for underground workers, except in cases of emergency. The Lessee shall employ no person under the age of 16 years in any mine below the surface. If the laws of the State in which the mine is situated prohibit the employment, in a mine below the surface, of persons of an age greater than 16 years, the Lessee shall comply with those laws.

Sec. 17. Assignment. This Lease may be assigned in whole or in part in accordance with the provisions of 43 CFR Subpart 3506. No assignment may be made where: (a) the proposed assignee is not qualified to hold a Lease under Section 1 of the Act (30 U.S.C. § 181); (b) the proposed assignee is unable to provide an adequate bond; (c) in the case of a proposed partial assignment, either the assigned or the retained portion of the Lease would, in the opinion of the Lessor, be too small to be economically developed; or (d) in the case of a proposed partial assignment, the Lessor does not approve the division of the schedules on which the advance royalties would be based.

Sec. 18. Overriding Royalties. The Lessee shall not create, by assignment or otherwise, an overriding royalty interest in excess of 50 percent of the rate of royalty payable to the United States under this Lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, except that where an interest in the Leased Lands or in an operating agreement is assigned, the assignor may retain any overriding royalty interest in excess of 50 percent if he shows to the satisfaction of the Bureau that he has made substantial investments for improvements on the Leased Lands covered by the assignment.

Sec. 19. Heirs and Successors-in-interest. Each obligation hereunder shall extend to, and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties thereto.

Sec. 20. Unlawful Interest. No member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(3), shall be admitted to any share or part in this Lease or derive any benefit that may arise therefrom; and the provisions of section 3741 of the Revised Statutes, as amended, 41 U.S.C. §22, and the Act of June 25, 1948, 62 Stat. 702 as amended, 19 U.S.C. §§ 431-433, relating to contracts, enter into and form a part of this Lease insofar as they may be applicable.

Sec. 21. Taxes. The Lessee shall pay, when due, all taxes lawfully assessed and levied upon improvements, outputs of mines, or other rights, property, or assets of the Lessee under the laws of the United States and the State in which the Leased Lands are located.

Sec. 22. Monopoly and Fair Practices. The Lessor reserves full authority to promulgate and enforce orders and regulations under the provisions of sections 30 and 32 of the Act (30 U.S.C. §§ 187,189) necessary to insure that any sale of the production from the Leased Lands to the United States or to the public is at reasonable prices, to prevent monopoly, and to safeguard the public welfare, and such regulations shall upon promulgation be binding upon the Lessee.

Sec. 23. Relinquishment of Lease. Upon a satisfactory showing to the Lessor that he has complied with the terms and conditions of this Lease, the Lessee may surrender the entire Lease or any legal subdivision thereof. A relinquishment must be filed in duplicate with the District Manager. Upon approval of the relinquishment by the District Manager, the relinquishment shall be effective as of the date it is filed, subject to the continued obligation of the Lessee and his surety to make payment of all accrued rentals and royalties, to deliver the premises in compliance with section 27 of this Lease, and to comply with all other applicable requirements of this Lease.

Sec. 24. Proceedings in Case of Default. (a) If the Lessee shall fail to comply with any of the terms and conditions of this Lease, including the terms and conditions of the exploration and mining plans required by sections 10 and 11 of this Lease, and that default shall continue for a period of 30 days after service of notice thereof by the Lessor, the Lessor may (1) suspend operations until the required action is taken to correct noncompliance, or (2) institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this Lease as provided in section 31 of the Act (30 U.S.C. § 188) and for forfeiture of all or part of any applicable bond. Any forfeiture and cancellation of this Lease shall not relieve the Lessee of his obligation to pay all rentals and royalties which have accrued as of the date of the forfeiture and cancellation, to deliver the premises in compliance with section 27 of this Lease and to comply with all other applicable requirements of this Lease.

(b) If the Lessee fails to take prompt and necessary steps to prevent loss or damage to the mine or other parts of the Leased Lands, or to prevent danger to the employees, or to avoid, or, where avoidance is impracticable, to minimize and, where practicable, repair damage to the environment, or, if immediate action by the Lessor, without waiting for action by the Lessee, is required for any of those purposes, the Lessor may enter on the premises and take such measures as he may deem necessary to prevent such loss, damage, or danger, or to correct the damaging, dangerous, or unsafe condition of the mine or any other facilities upon the Leased Lands, and those measures shall be at the expense of the Lessee.

Sec. 25. Waiver of Conditions. The Lessor reserves the right to waive any breach of the conditions contained in this Lease, except the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the Lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this Lease for any other cause, or for the same cause occurring at another time.

Sec. 26. Readjustment of Terms and Conditions. The Lessor may propose the reasonable readjustment of any terms and conditions of this Lease, the first readjustment to be effective at the twentieth Anniversary Date of this Lease and subsequent readjustments to be effective at twenty Lease Year intervals thereafter. At least 120 days before the appropriate Anniversary Date, the Lessor shall give notice to the Lessee of any proposed readjustment of the terms and conditions of the Lease and the nature thereof, and, unless the Lessee, within 60 days after receipt of such notice, files with the Lessor an objection to the proposed terms or relinquishes the Lease as of the appropriate Anniversary Date, the Lessee shall be deemed conclusively to have agreed to such terms and conditions. If the Lessee files objections with the Lessor and agreement cannot be reached between the Lessor and the Lessee within a period of 60 days after the filing of the objection, the Lease may be terminated by either party upon giving 60 days' notice to the other party; however, the Lessor's right to terminate the Lease shall be suspended by the Lessee's filing of a notice of appeal pursuant to section 32 of this Lease, and if the Lessee is ultimately successful in his appeal, the Lease shall continue without the change in the provisions, the imposition of which the Lessee appealed. If the Lessee is unsuccessful in his appeal and, within 60 days of the decision on appeal notifies the Lessor that he accepts the decision rendered upon such appeal, then the Lease shall continue as amended by the decision. If the Lessee files objections to the proposed readjusted terms and conditions, the existing terms and conditions, except those concerning royalties, shall remain in effect until there has been an agreement between the Lessor and the Lessee on the new terms and conditions to be incorporated in the Lease, or until the Lessee has exhausted his rights of appeal under section 32 of this Lease, or until the Lease is terminated; however, the readjusted royalty provisions shall be effective until there is either agreement between the Lessor and the Lessee or until the Lease is terminated. If the readjusted royalty provisions are subsequently rescinded or amended, the Lessee shall be permitted to credit any excess royalty payments against royalties subsequently due to the Lessor.

Sec. 27. Delivery of Premises. (a) In case of the termination of this Lease for any reason, the Lessee shall deliver the premises to the Lessor in accordance with the reclamation requirements of the exploration and mining plans required under sections 10 and 11 of this Lease, and subject to the provisions in this section.

(b) All permanent improvements and other property on the Leased Lands, whether affixed to the ground or movable, including all underground shafts and timbering, well casing or other underground development works, or any other property which the Lessor shall inform the Lessee is necessary for the preservation of the Leased Lands, shall become and remain thereafter a part of the realty without the payment of any compensation to the Lessee. All other structures, equipment, machinery, tools, appliances, and materials on the Leased Lands, whether affixed to the ground or movable, shall remain the property of the Lessee upon the termination of the Lease, but the Lessee shall have no right, for a period of six months following the termination, to remove from the Leased Lands any of that property which in the opinion of the Lessor is useful for the protection of the Leased Lands (including any mines in those lands) unless the Lessor shall expressly authorize the removal. During the six-month period the Lessor shall have the right to purchase at the appraised value any or all items on that property. The appraised value shall be fixed by three disinterested and competent persons (one to be designated by the Lessor, one by the Lessee, and the third by the two so designated), and the appraised value determined by the three, or a majority of them or, if at least two cannot agree on an appraisal, an average of the three appraisals shall be conclusive.

(c) Any structures, machinery, equipment, tools, appliances, and materials, subject to removal by the Lessee as provided above, which are allowed to remain on the Leased Lands shall become the property of the Lessee one year after the termination of this Lease or any extension of that one-year period which may be granted by the Lessor because of adverse climatic conditions or other good and sufficient reason, unless the Lessor shall direct the Lessee to remove any or all of such property before the expiration of the one-year period. If the Lessor directs the Lessee to remove such property, the Lessee shall do so at his own expense or, if he fails to do so within a reasonable period, the Lessor may do so at the Lessee's expense.

Sec. 28. Production and Disposition Records. The Lessee shall maintain books in which will be kept a correct account by weight of all Coal mined; Coal sold, to whom sold and the price received; Coal stored and Coal used on the Leased Lands; and Coal otherwise disposed of.

Sec. 29. Inspections and Investigations. (a) All books and records maintained by the Lessee showing information required by this Lease or regulations must be kept current and in such manner that the books and records can be readily checked, upon request, by the Mining Supervisor or his representative at the place where they are customarily maintained or kept.

(b) The Lessee shall permit any duly authorized officer or representative of the Lessor at any reasonable time (1) to inspect or investigate the Leased Lands and all surface and underground improvements, works, machinery, and equipment, and all books and records pertaining to the Lessee's obligations to the Lessor under this Lease and regulations and (2) to copy and make extracts from any such books and records.

Sec. 30. Proprietary Information. Geological and geophysical interpretations, maps, and data and commercial and financial information required to be submitted under this Lease shall not be available for public inspection without the consent of the Lessee so long as the Lessee furnishing such data, or his successors or assignees, continues to hold this Lease and the land in connection with which the data has been submitted is subject to this Lease.

Sec. 31. Lessee's Liability to Lessor. (a) The Lessee shall be liable to the United States for any damage suffered by the United States in any way arising from or connected with the Lessee's activities and operations under this Lease, except where damage is caused by employees of the United States acting within the scope of their authority.

(b) The Lessee shall indemnify and hold harmless the United States from any and all claims arising from or connected with the Lessee's activities and operations under this Lease.

(c) In any case where liability without fault is imposed on the Lessee pursuant to this section, and the damages involved were caused by the action of a third party, the rules of subrogation shall apply in accordance with the law of the jurisdiction where the damages occurred.

Sec. 32. Appeals. The Lessee shall have the right of appeal (a) under 43 CFR 3000.4 from any action or decision of any official of the Bureau, (b) under 30 CFR Part 290 from any action, order, or decision of any official of the Geological Survey, or (c) under applicable regulation from any action or decision of any other official of the Department of the Interior arising in connection with this Lease, including any action or decision pursuant to section 26 of this Lease with respect to the readjustments of terms and conditions.

THE UNITED STATES OF AMERICA

By ______________________
(Signing Officer)

State Director
(Title)

JUN 11 1975
(Date)

WITNESS TO SIGNATURE OF LESSEE

R.W. Sullivan

MORGAN COAL COMPANY

By ______________________
(Signature of Lessee)
Harrison Eiteljorg, Managing Partner

____
(Signature of Lessee)

____
(Signature of Lessee)

(If this Lease is executed by a corporation, it must bear the corporate seal)

COAL LEASE ENVIRONMENTAL STIPULATIONS

SECTION 1. GENERAL.

(A) Applicability of Stipulations.

The terms, conditions, requirements and prohibitions imposed upon the Lessee by these Stipulations are also imposed upon the Lessee's agents, employees, contractors, and sub-contractors, and their employees. The failure or refusal of the Lessee's agents, employees, contractors, or sub-contractors, or their employees, to comply with these Stipulations shall be deemed to be the failure or refusal of the Lessee. The Lessee shall require his agents, contractors, and sub-contractors to include these Stipulations in all contracts and sub-contracts which are entered into by any of them, together with a provision that the other contracting party, and his agents, employees, contractors, and sub-contractors, and the employees of each of them, shall likewise be bound to comply with these Stipulations.

(B) Changes in Conditions.

These Stipulations are based on existing knowledge and technology. They may be revised or amended, in writing, by the mutual consent of the Mining Supervisor, the District Manager, and the Lessee at any time to adjust to changed conditions or to correct an oversight. Such revisions or amendments may result from, but not be limited to, the Environmental Impact Statement currently being prepared in northwest Colorado on Coal. The Lessor may amend these Stipulations at any time without the consent of the Lessee in order to make these Stipulations consistent with any new Federal of State statutes and with regulations issued under those statutes. The Lessee, the Mining Supervisor, and the District Manager shall meet at least once a year to review advances in technology and, in a mutual endeavor, weigh and decide the feasibility and need of revising or amending existing Stipulations.

The Lessor and the Lessee agree that, in this mutual endeavor to decide upon the feasibility and need for amending the existing Stipulations, they will act in good faith and in a sincere effort to make the Lessee's activities under the lease as free from environmental damage as is practicable. Systems which require pollution control devices shall, whenever possible, possess sufficient flexibility to adopt improved technology when the improvements are available, and the systems shall be constructed with the understanding that continued compliance with changing pollution control laws is required.

(C) Emergency Decisions.

Any decisions or approvals of the Mining Supervisor or District Manager required by these Stipulations to be in writing may in emergencies be issued orally, with written confirmation as soon thereafter as possible.

(D) Construction Standards.

The general design of all buildings and structures shall comply with the latest edition of the Uniform Building Code (U.B.C.). Steel structures shall be designed in accordance with the latest edition of the American Institute of Steel Construction, "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings." Reinforced concrete shall comply with the latest edition of the American Concrete Institute's "Building Code Requirements for Reinforced Concrete." Engineering works for impoundments shall conform to standard engineering practice sufficient to prevent environmental damage which could result from a 100-year flood in the drainage in which installed.

SECTION 2. ACCESS AND SERVICE PLANS.

(A) Pipelines.

In the design, construction and operation of pipelines and the choice of materials for them, the Lessee shall follow the standards (wherever they may be made applicable) established by the Department of Transportation and, if these standards should ever be revised, supplemented, or superseded, shall follow the new standards. These standards include:

(1) 49 CFR 192, Transportation of Natural and Other Gas by Pipeline;

(2) 49 CFR 195, Transmission of Liquids by Pipeline;

(3) 49 CFR, Part 110, Carriers by Pipeline (Other than Natural Gas and Water).

(B) Electric Transmission Facilities.

The Lessee shall design and construct telegraph and telephone lines, electric powerlines, distribution lines and other transmission facilities on the leased lands in accordance with the guidelines set forth in "Environmental Criteria for Electric Transmission Systems," (U.S.D.I., U.S.D.A., 1970), as now or in the future amended, or if these guidelines should be superseded, in the guidelines or other rules superseding them. Distribution lines shall be designed and constructed in accordance with REA Bulletin 61-10, "Powerline Contacts by Eagles and Other Large Birds," as now or in the future amended, or, if these guidelines should be superseded, in the guidelines or other rules superseding them. Nothing in this subsection shall be deemed to require the reconstruction of facilities which at the time of their construction were in compliance with existing rules or guidelines.

(C) Existing and Future Roads and Other Rights-of-Way.

Where feasible, the Lessee shall use existing railroads, roads, trails, and other rights-of-way. Unless the Lessor shall direct otherwise, future railroads, roads, trails and other rights-of-way shall be located, constructed, maintained, and closed according to the specifications of the Bureau and shall include drainage structures where needed.

The Lessee has the responsibility for securing access rights-of-way.

(D) Regulation of Public Access.

After construction on rights-of-way is completed, the Lessee shall, upon consultation with the Lessor, permit reasonable, free and unrestricted public access to and upon roads and other rights-of-way for all lawful and proper purposes except to mine sites, disposal areas, operational haul roads, and other operational areas which may be closed to the general public. The Lessee shall regulate public access and public vehicular traffic as required to facilitate operations and to protect the public and, to the extent reasonable, livestock and wildlife from hazards associated with mining operations. For this purpose, the Lessee shall provide warnings, flagmen, barricades, and other public safety measures as necessary. Whenever the Mining Supervisor shall determine that the Lessee's regulation of access and traffic is unreasonable, or that the Lessee's provision of public safety measures is inadequate, he shall so inform the Lessee who shall immediately take corrective measures.

(E) Waterbars and Breaks.

The Lessee shall divert runoff from roads and uphill slopes by means of waterbars, waterbreaks, or culverts constructed in accordance with Bureau specifications.

(F) Barriers.

Where a railroad, road, trail, pipeline, transmission facility or exploratory site cuts a natural barrier used for livestock control, the Lessee shall, at his own expense, close the opening by the use of a fence or other suitable barrier. All fences, cattleguards and other barriers constructed by the Lessee shall meet established Bureau specifications and standards.

(G) Crossings.

The Lessee shall take all steps necessary to make certain that railroads, roads, trails, pipelines, and transmission facilities constructed under this Lease do not prevent or unreasonably disrupt the use of existing roads, trails, pipelines, and other rights-of-way or major animal migration routes. This requirement shall include the construction of suitable overhead or underground crossings where they are determined to be necessary by the Mining Supervisor or the District Manager.

(H) Alternate Routes.

If any of the Lessee's activities on the leased lands shall interfere with the free use of existing roads and trails used by persons, whether or not recorded, he shall provide such alternate roads and trails as the Mining Supervisor or the District Manager may determine to be needed.

(I) Off-Road Vehicle Use.

The Lessee shall use off-road vehicles in a manner consistent with applicable Federal, State and local regulations.

SECTION 3. FIRE PREVENTION AND CONTROL.

(A) Instructions of the Mining Supervisor.

(1) The Lessee shall comply with regulations (including, but not limited to, 30 CFR, Parts 75, 77, 211, and 43 CFR, Part 23) and with the instructions and directions of the Mining Supervisor concerning the use, prevention, and suppression of fires, and shall make every reasonable effort to prevent, control and suppress any fire on Leased Lands. Uncontrolled fires must be immediately reported to the Mining Supervisor and District Manager.

(2)(a) The Lessee shall construct fire lines or perform clearing when necessary to fight fires or, when determined by the Mining Supervisor or the District Manager to be necessary, to prevent such fires.

(b) The Lessee shall comply with the National Fire Codes on handling, transportation, storage, use and disposal of flammable liquids, gases and solids.

(c) The Lessee shall take all appropriate actions to prevent coal outcrop fires.

(B) Liability of Lessee.

The control and suppression of any fires on the Leased Lands (or on adjoining public lands which have spread from the Leased Lands) caused by the Lessee or his employees, contractors, subcontractors, or agents shall be at the expense of the Lessee. Upon the failure of the Lessee to control and suppress any such fires in a manner satisfactory to the Mining Supervisor or the District Manager, the Mining Supervisor or District Manager shall take such steps as are necessary to control and suppress the fire, either alone or in conjunction with other Federal, State, and local authorities, and the cost of such control and suppression shall be borne by the Lessee.

SECTION 4. FISH AND WILDLIFE.

(A) Management Plan.

The Lessee shall submit to the Mining Supervisor, as part of the mining plan required under Section 11 of this Lease, a detailed fish and wildlife management plan which shall include the steps which the Lessee shall take to: (1) avoid or, where avoidance is impracticable, minimize damage to fish and wildlife habitat, including water supplies; (2) restore, to the extent possible, such habitat in the event it is unavoidably destroyed or damaged; (3) provide alternate habitats where feasible; and (4) provide controlled access to the public for enjoyment of wildlife resources on the leased lands as may be mutually agreed upon. The plan shall include, but not be limited to, detailed information on activities, time schedules, performance standards, proposed accomplishments, and ways and means of avoiding or minimizing environmental impacts on fish and wildlife.

(B) Mitigation of Damage.

Wherever destruction or significant disturbance of fish and wildlife habitat is inevitable, the Lessee shall submit, for the Mining Supervisor's approval at least 60 days prior to the destruction or damage of the habitat, those measures which the Lessee proposes to take to avoid, or, where avoidance is impracticable, minimize and repair injury or destruction of fish and wildlife and their habitat. As a general rule, the proposed measures should provide for habitat of similar type and equal in quantity and quality to that destroyed or damaged. The Mining Supervisor shall, within 60 days after the submission of the proposed measures to him, either approve or disapprove them. If he shall approve them, the Lessee shall execute the proposed measures for the mitigation of the destruction or damage of the habitat. If the Mining Supervisor shall disapprove the measures, he shall offer the Lessee an opportunity for consultation at which, whenever possible, he shall inform the Lessee of any changes which will make the measures acceptable.

(C) Big Game.

The Lessee shall construct big game drift fences when and where necessary to direct big game movements around or away from operational areas as prescribed by the Mining Supervisor.

(D) Posting of Notices.

The Lessee shall post in reasonable and conspicuous places on or adjacent to the Leased Lands notices informing its employees, agents, contractors, subcontractors, and their employees, of all applicable laws and regulations governing hunting, fishing, and trapping.

SECTION 5. HEALTH AND SAFETY.

(A) General.

The Lessee shall take all measures necessary to protect the health and safety of all persons affected by its activities and operations and shall immediately abate any activity or condition which generally threatens the life or health of persons or which threatens any person with bodily harm.

(B) Housing and Welfare of Employees.

In the exercise of his right under Section 1 of the Lease to construct buildings and other facilities for the welfare of his employees, the Lessee shall at all times make certain that these facilities are situated, constructed, operated, and maintained in an orderly manner, satisfactory to the Mining Supervisor or District Manager. While no general restriction is imposed upon the construction of facilities necessary to the employees' health and well-being, such construction shall be subject to the Mining Supervisor's or District Manager's approval and shall not unreasonably damage the environment of the Leased Lands.

Construction of housing and other facilities on the Leased Lands shall require the written approval of the District Manager and shall be subject to county zoning regulations. At the termination of the lease, the Lessee agrees to remove or otherwise dispose of housing and service buildings or any other such facilities to the satisfaction of the Mining Supervisor or District Manager.

(C) Compliance with Federal Health and Safety Laws and Regulations.

The Lessee shall comply with the Federal Coal Mine Health and Safety Act of 1969, 83 Stat. 742, as amended, 30 U.S.C.,§§ 801-960, as now in effect or as hereafter amended, or, if it should be superseded, with the statute superseding it; or, if applicable, the Occupational Safety and Health Act of 1970, 84 Stat. 1590, 29 U.S.C., §§ 651-678, as now in effect, or as hereafter amended, or, if it should be superseded, with the statute superseding it; and all health and safety standards and regulations promulgated pursuant to such statutes.

(D) Use of Explosives.

The Lessee shall insure that explosives are used only in accordance with existing State and Federal laws and the requirements specified by the Mining Supervisor. The Lessee shall provide adequate advance written notice by publication or posting of planned blasting schedules to local governments and to residents who might be affected by the use of such explosives, and he shall maintain for a period of at least two years a log of the magnitudes and times of blasts. The Lessee shall limit the type of explosives and detonating equipment, the size, the timing and frequency of blasts based upon the physical conditions of the site so as to prevent injury to persons, damage to public and private property outside the mining site, adverse impacts on any underground mine, and change in the course, channel, or availability of ground or surface water outside the mining site.

SECTION 6. HAZARDOUS MATERIALS.

(A) Responsibility.

If, during operations, any hazardous substance should be discharged, the control, removal, disposal, and cleanup of that substance, wherever found, shall be the responsibility of the Lessee. Upon the failure of the Lessee to control, remove, dispose of, or clean up the discharge, or to repair all damages resulting therefrom, the Mining Supervisor may take such measures as he deems necessary to control, remove, dispose of, or clean up the discharge and restore the area, including, where appropriate, the aquatic environment and fish and wildlife habitats, at the full expense of the Lessee. Such action by the Mining Supervisor shall not relieve Lessee of any responsibility as provided in this Lease.

(B) Reporting of Spills and Discharges.

The Lessee shall give immediate notice of any spills or discharges of hazardous substances to: (1) the Mining Supervisor and (2) such other Federal and State officials as are required by law to be given such notice. Any oral notice shall be confirmed by the Lessee in writing as soon as possible.

(C) Storage and Handling.

The Lessee shall store oil, petroleum products, industrial chemicals and similar toxic or volatile materials in durable containers and locate such materials so that any accidental spillage will not drain into water courses, lakes, reservoirs, or ground water. Unless otherwise approved by the Mining Supervisor, the Lessee shall store substantial quantities (more than 500 gallons) of such materials in an area surrounded by impermeable containment structures. The volume of the containment structures shall be at least: (1) one-hundred fifty (150) percent of the total storage volume of storage tanks in the relevant area; plus (2) a volume sufficient for maximum trapped precipitation and run-off which might be impounded at the time of a spill.

(D) Pesticides and Herbicides.

The Lessee shall not use pesticides and herbicides without the approval of the District Manager (except that within the area of Leased Lands in which actual mining operations are being conducted, this authority shall be supervised by the Mining Supervisor). Pesticides and herbicides shall be considered treatments of last resort to be used only when reasonable alternatives are not available and where their use is consistent with protection and enhancement of the environment. Where pesticides and herbicides are used, they shall be used only with the approval of the Mining Supervisor and the type, amount, method of application, storage, and disposal shall be in accordance with applicable Federal and State procedures.

SECTION 7. POLLUTION--AIR

(A) Air Quality.

The Lessee shall utilize and operate all facilities and devices in such a way as to avoid, or, where avoidance is impracticable, minimize air pollution. At all times during construction and operation, the Lessee shall conduct activities in accordance with all applicable air quality standards and related plans of implementation adopted pursuant to the Clean Air Act, 77 Stat. 392 as amended, 42 U.S.C. §§ 1857, as now in effect or as hereafter amended, of if it should be superseded, the statute superseding it, and applicable State standards.

(B) Dust.

The Lessee shall make every reasonable effort to avoid, or where avoidance is impracticable, minimize dust problems. The Mining Supervisor may require sprinkling, oiling, or other means of dust control on roads, trails, etc. The Lessee shall conduct processing so as to prevent, or if prevention is impossible, minimize to the maximum extent possible, environmental or health problems associated with dust.

(C) Burning.

Open burning is permitted only after securing a burning permit from the Colorado Air Pollution Control Commission. A copy of such burning permit shall be presented to the District Manager and the Mining Supervisor for their approval prior to conducting any such burning.

SECTION 8. POLLUTION -- WATER.

(A) General.

The Lessee shall utilize and operate all facilities and devices in accordance with State and Federal statutes (including, but not limited to, the Federal Water Pollution Control Act, 62 Stat. 1155, as amended, 33 U.S.C., §§ 1251-1376) and regulations as now in effect or as hereafter amended, or if they should be superseded, the statute and regulations superseding them, and he shall minimize the disturbance to the prevailing hydrologic balance at the mine site and in associated off-site areas and to the quality and quantity of water in surface and ground water systems, during both coal mining and reclamation operations, by:

(1) Avoiding acid or other toxic mine drainage by such measures as, but not limited to, preventing or removing water from contact with toxic-producing deposits; treating drainage to reduce toxic content which adversely affects downstream water upon being released to water courses; containing harmful ground water encountered in the mining operation; or casing, sealing, or otherwise managing bore holes, shafts, and wells to keep acid or other toxic drainage from entering ground and surface waters;

(2) Conducting surface mining operations so as to prevent to the maximum extent practicable additional contributions of suspended solids to stream flow or runoff outside the mining site above natural levels under seasonal flow conditions as measured prior to any mining, and avoiding channel deepening or enlargement in operations requiring the discharge of water from mines;

(3) Removing temporary or large siltation structures from drainways after disturbed areas are revegetated and stabilized;

(4) Restoring, to the maximum extent possible, recharge capacity of the aquifer at the mine site to approximate premining conditions;

(5) Preserving to the maximum extent practicable, through the mining and reclamation process, the hydrologic integrity of alluvial valley floors in arid and semiarid areas;

(6) Implementing such other measures as the Mining Supervisor may prescribe.

(B) Disturbance of Existing Waters.

(1) All activities, exclusive of actual mining activities, that may cause the creation of new lakes, drainage of existing ponds, diversion of natural drainages, alteration of stream hydraulics, disturbance of areas of stream beds or degradation of land and water quality or adversely affect the environmental integrity of the area are prohibited unless approved in writing by the Mining Supervisor and with the owners' prior written consent.

(2) The location of crossings of perennial streams, lakes and rivers must be approved in writing by the Mining Supervisor.

(3) In conducting all activities, including actual mining activities, the Lessee shall, to control erosion, maintain buffer strips at least 200 feet wide on each side of a stream in their natural and undisturbed state unless otherwise authorized in writing by the Mining Supervisor.

(4) In addition to complying with the provisions of subsection (3), the Lessee shall not cut or fill near or in streams or drainages if it would result in siltation or accumulation of debris unless approved in writing by the Mining Supervisor.

(C) Road Surfacing Material.

All road surfacing material used by the Lessee must be approved by the Mining Supervisor or the District Manager.

SECTION 9. POLLUTION -- NOISE.

The Lessee shall comply with all applicable Federal, State or local standards on noise pollution, as now in effect or as hereafter amended, or, if they should be superseded, the standards superseding them. In the absence of specific noise pollution standards, the Lessee shall keep noise at or below levels safe and acceptable for humans, as determined by the Mining Supervisor or the District Manager.

SECTION 10. REHABILITATION.

The Leased Lands shall be rehabilitated in a manner that will avoid or minimize environmental impacts off the Leased Lands and be in accordance with Federal, State and local surface rehabilitation statutes and regulations.

SECTION 11. CLEARING AND STRIPPING

The Lessee may clear and strip only such lands as are necessary for mining, processing, and other operations under the Lease. In connection with such operations, the Lessee may clear and strip land necessary for roadbeds, but the widths of such roadbeds shall be not more than 25 feet from the centerline, unless otherwise specified by the Mining Supervisor or District Manager.

SECTION 12. WASTE DISPOSAL.

Disposal of mine and other wastes shall be carried out pursuant to applicable Federal, State and local laws and regulations.

SECTION 13. SCENIC VALUES.

(A) Scenic Considerations in General.

The Lessee shall, except where the Mining Supervisor or District Manager has approved otherwise, use the following standards in all designing, clearing, earthmoving, and construction:

(1) Contours compatible with the natural environment shall be used to avoid straight lines wherever feasible.

(2) Natural colors consistent with the local environment such as pastels or muted shades of brown, green, red, or grey shall be used in the painting of facilities installed on the Leased Lands. Bright or unnatural colors shall be avoided except for use in warning signs or other markings for safety purposes.

(3) Small natural openings or the edges of larger openings in the natural environment shall be utilized in the construction of facilities or disturbing the land surface whenever feasible.

(4) During the time when the land is disturbed, the portion of land which is not under revegetation programs shall only be those areas required under the mining plan for mining, storage, or processing operations.

(B) Consideration of Aesthetic Values.

The Lessee shall consider existing aesthetic values in all planning, construction, reclamation and mining operations. All roads, trails, railroads, pipelines and transmission lines shall, where practicable, be constructed so as to minimize visual impact, to make use of the natural topography, and, wherever feasible, to achieve harmony with the landscape.

(C) Protection of Landscape.

The Lessee shall design any structures and facilities built under this Lease so that they will, to the extent practicable, blend with the natural landscape.

(D) Signs.

The Lessee shall design and construct signs that are rustic in appearance, except for warning signs and other marking for safety purposes, and they shall conform to the sign standards of the Bureau.

SECTION 14. ANTIQUITIES AND OBJECTS OF HISTORIC AND SCIENTIFIC VALUE.

(A) "Cultural resources," for the purpose of this section, shall be defined as any district, site, building, structure, or object of American historical, scientific prehistoric, archaeological, or architectural significance. Prior to the submission of any exploration or mining plan, the Lessee shall engage a qualified independent expert who shall conduct a survey, acceptable to the District Manager, of the lands to be disturbed under that plan and immediately adjoining lands to determine the existence of cultural resources. (Information collected prior to the Effective Date as to cultural resources on the Leased Lands shall, with the approval of the District Manager, satisfy all or part of the survey requirements of this section.) The expert conducting the survey shall be a person acceptable to the District Manager and the terms and conditions of the contract under which the survey is conducted shall be subject to approval of the District Manager. The contract shall provide that the expert shall be directly responsible to the Lessor, and the Lessor shall, upon approval of the contract, become a party thereto. The District Manager shall approve (or disapprove, as the case may be) the contract not later than 30 days after the Lessee submits the contract to him. The survey, at the discretion of the Lessee, may be in two parts, one covering the lands which are the subject of the exploration plan and one covering the lands which are the subject of the mining plan, or may be in one part including the lands which are the subject of both the exploration plan and the mining plan. The responsibility and cost of the survey and of any salvage that may be required as a result of such survey will be that of the Lessee. No plan in connection with which a survey is prepared shall be approved before the expert has completed a survey acceptable to the District Manager. In order that the requirements of this section may be expeditiously fulfilled, the Lessee may elect to have the expert on hand during exploration or mining to complete the necessary survey of additional lands not covered by the initial survey before those lands are disturbed pursuant to changes which the Mining Supervisor approves in the exploration or mining plan. In the event that the survey identifies cultural resources, the plan shall contain provisions to avoid the disturbance of such discoveries until the Lessee and the Lessor have complied with the law with respect to such discoveries.

(B) The Lessee shall immediately bring to the attention of the Mining Supervisor any cultural resources discovered as a result of operations under this Lease and shall leave such discoveries intact. The Mining Supervisor shall immediately inform the District Manager of the discovery and the District Manager shall, within ten days thereafter, evaluate the discoveries brought to his attention to determine whether such discoveries may be potentially qualified for inclusion in the National Register of Historic Place or may be otherwise significant as a cultural resource. If the District Manager shall make such determination in the affirmative, he shall immediately refer this determination to the appropriate officer of the Department of the Interior for review and approval of potential qualification, which shall be made within ten days thereafter. During this period for determination and evaluation of the discovery, the Lessee shall comply with the directions of the District Manager so as to avoid the disturbance of the cultural resource.

THE UNITED STATES OF AMERICA

By ______________________
(Signing Officer)

WITNESS TO SIGNATURE OF LESSEE

State Director
(Title)

____

JUN 11 1975
(Date)

____

R. W. Sullivan

MORGAN COAL COMPANY

By ______________________
(Signature of Lessee)
Harrison Eiteljorg, Managing Partner

____
(Signature of Lessee)

____
(Signature of Lessee)

(If this Lease is executed by a corporation, it must bear the corporate seal)

Atty
Flume
Abernethy
Smith
Beal
Northrop

4—696
(August 1942)

UNITED STATES
DEPARTMENT OF THE INTERIOR

DISTRICT LAND OFFICE Denver

SERIAL NO. 052547

MINING LEASE OF COAL LANDS UNDER ACT OF FEBRUARY 25, 1920

This indenture of lease, entered into, in quintuplicate, this 1st day of March A. D. 1945, by and between the United States of America, acting in this behalf by the Assistant Secretary of the Interior, party of the first part, hereinafter called the lessor, and Thomas P.Greenhelgh, of Hiawatha, Utah, party of the second part, hereinafter called the lessee, under, pursuant, and subject to the terms and provisions of the act of Congress, approved February 25, 1920 (41 Stat. 437), entitled "An act to promote the mining of coal, phosphate, oil, oil shale, gas, and sodium on the public domain," hereinafter called the "act."

WITNESSETH:

That the lessor, in consideration of the rents and royalties to be paid and the covenants to be observed as hereinafter set forth, does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in, upon, or under the following described tracts of land, situated in the State of Colorado, to wit: Lots 2, 3, SE¼ sec. 9, T. 4 N., S½SE¼ sec. 29, NE¼, NE¼SE¼ sec. 32, W½ sec. 33, T. 5 N., all in R. 86 W., 6th P.M., containing 853.27 acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

SECTION 1. That the lessor expressly reserves:

(1*a*) The right to permit for joint or several use such easements or rights of way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in said act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(1*b*) The right to lease, sell, or otherwise dispose of the surface of said lands or any part thereof under existing law or laws hereafter enacted, in so far as said surface is not necessary for the use of the lessee in the mining and removal of the coal therein, and to lease other mineral deposits in the lands, under the provisions of said act.

(1*c*) Full power and authority to carry out and enforce all the provisions of Section 30 of said act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly; and to safeguard the public welfare.

SECTION 2. The lessee in consideration of the lease of the rights and privileges aforesaid hereby covenants and agrees as follows:

(2*a*) To invest in actual mining operations, development, or improvements upon the land leased, or for the benefit thereof, the sum of fifty thousand dollars, of which sum not less than one-third shall be so expended during the first year succeeding the execution of this instrument and a like sum each of the two succeeding years, unless sooner expended; and submit annually, at the expiration of each year for the said period, an itemized statement of the amount and character of said expenditure during such year.

(2*b*) To furnish a bond in the sum of $10,000 conditioned upon the expenditure of the amount specified in (2*a*) hereof and upon compliance with all the other terms of the lease. (In case of a $10,000 bond, a bond in the sum of $5,000 may be substituted after the investment requirement has been met.)

(2*c*) To pay as an annual rental for each acre or part thereof covered by this lease, the sum of 25 cents per acre for the first year, payment of which amount is hereby acknowledged, the sum of 50 cents per acre per year for the second, third, fourth, and fifth years, and $1 per acre for the sixth and each succeeding year during the life of

10—30652-1

Posted 3/17/45 - Vol. 108 - P.244 - R.L./O.

this lease, all such annual payments of rental to be made to the register of the District Land Office of the district in which said land is situated, on the anniversary of the date hereof, and to be credited on the first royalties to become due hereunder during the year for which said rental was paid.

(2d) To pay to such register a royalty of 15 cents on every ton of 2,000 pounds of coal mined during the first two years succeeding the execution of this lease, and a royalty of not less than 10 cents a ton at any time thereafter when in the opinion of the Secretary of the Interior a reduction in the rate is warranted. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

the weight or weights thereof in due form in books to be kept and preserved by the lessee for such purpose.

(2*f*) To furnish quarterly, within 30 days after the expiration of the quarter, a written report covering such quarter, certified under oath by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the number of tons of 2,000 pounds of coal mined during the quarter, the character and quality thereof, amount of coal and products and by-products thereof disposed of and price received therefor, amount of coal and its products in storage or held for sale, and amount used in operations under this lease.

(2*g*) Also to furnish annually, and at such other times as the Secretary of the Interior may require, in the manner and form prescribed by the Secretary of the Interior, plat, map, or tracings showing all development work and improvements upon the leased lands, and other related information, with a report as to all buildings, structures, or other works placed in or upon the leased lands, a statement as to the amount and grade of coal produced and sold, and amount received therefor by operations hereunder, and, if a corporation, the amount of capital stock and list of its stockholders.

(2*h*) To keep at the mine office clear, accurate, and detailed maps, on a scale not more than 200 feet to the inch, in the form of horizontal projections on tracing cloth, of the workings in each coal bed in each separate mine on the leased lands, a separate map to be made for each such bed, and for the surface immediately over the underground workings, and to be so arranged with reference to a public land corner that the maps can be readily superimposed.

Each map of the workings in any coal bed shall show the thickness of the coal and of partings, and the dip and strike of each bed at intervals of 500 feet or less; the location of all openings connecting such bed with the workings in any other bed, or with any adjacent mine, or with the surface; the location of all entries, gangways, rooms, or breasts, and all other mine openings, shafts, airways, appliances, and devices, constructed or placed in the mine or any of the workings thereof; and such maps shall also show the elevation relative to sea level or a Government survey corner of the principal points of the various beds and workings.

Blue prints or reproductions in duplicate of the maps required as aforesaid shall be furnished the lessor when made, and supplemental prints or reproductions in duplicate furnished on or before the first day of each succeeding year, showing the extensions, additions, and changes since the last map or supplement was submitted. All mine progress maps kept by the lessee shall at all times be subject to examination by lessor.

(2*i*) That, beginning with the fourth year of the lease, except when such operation shall be interrupted by strikes, the elements, or casualties not attributable to the lessee, the lessee shall mine and pay a royalty on not less than 25,000 tons of coal per year, unless on application and showing made, operations shall be suspended for not exceeding six months at any one time, pursuant to section 7 of the act; or unless the lessee shall pay the royalty less rent, on such minimum amount of coal, for one year in advance, in which case operations may be suspended for that year.

(2*j*) That the lessee shall not assign this lease or any interest therein, nor sublet any portion of the leased premises without the written consent of the lessor being first had and obtained.

Section 3. It is mutually understood and agreed that the lessor shall have the right to readjust and fix the royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof, and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period, but in case the lessee be dissatisfied with the rate of royalty or other terms and conditions so fixed, he may terminate this lease in the manner and under the conditions provided in Sections 6 (*b*) and 6 (*c*) hereof.

J.P.K.

The lessee shall not discriminate against any employee or applicant for employment because of race, creed, color, or national origin, and shall require an identical provision to be included in all subcontracts.

SECTION 4. This lease is made subject to the following provisions, which the lessee accepts and covenants faithfully to perform and observe, unless the laws of the State where the leased land or deposits are situated otherwise provide, in which case such State laws control:

(*4a*) The lessee shall carry out and observe regulations prescribed by the Secretary of the Interior and in force at the date hereof relative to (1) reasonable diligence, skill, and care in the operation of said property in accordance with approved methods and practices; (2) the prevention of undue waste; (3) the safety and welfare of miners; and (4) insuring the fair and just weighing or measurement of the coal mined by each miner.

(*4b*) And also shall pay all miners and other employees, both above and below ground, at least twice each month in lawful money of the United States, and shall permit such miners and other employees full and complete freedom of purchase, but with a view to increasing safety this provision shall not apply to the purchase of explosives, detonators, or fuses; and shall not require or permit miners or other employees, except in case of emergency, to work underground for more than eight hours in any one workday, and shall not employ any boy under the age of 16 years, or any girl or woman without regard to age in any mine below the surface.

SECTION 5. And the lessee also expressly agrees that all mining and related operations shall be subject to the inspection of authorized representatives of the lessor, and that such representatives, with all proper and necessary assistants, may at all reasonable times enter into and upon the leased lands and survey and examine same and all surface and underground improvements, works, machinery, equipment, and operations.

(*5a*) And also shall permit the lessor to examine all books and records pertaining to operations under this lease, and to make copies of and extracts from any or all of same, if desired.

(*5b*) And also shall permit the lessor or its lessees or transferees, with the approval of the lessor, to make and use upon or under the leased lands any workings necessary for freeing any other mine from water or gas, or extinguishing fires, causing as little damage or interference as possible to or with the mine or mining operations of the lessee hereunder; *provided*, that any such use by a transferee or another lessee shall be conditioned upon the payment to the lessee hereunder of the amount of actual damages sustained thereby and adequate compensation for such use.

(*5c*) And also shall, at the termination of this lease, as the result of forfeiture thereof, pursuant to paragraph (*6d*), deliver up to the lessor the lands covered thereby, including all fixtures, machinery, improvements, and appurtenances, other than strictly personal property, situate on any of said lands, in good order and condition, so as to permit of immediate continued operation to the full extent and capacity of the leased premises.

SECTION 6. It is further mutually understood and agreed as follows:

(*6a*) That the lessor may, in writing, waive any breach of the covenants and conditions contained herein, except such as are required by the act, but any such waiver shall extend only to the particular breach so waived, and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

(*6b*) The lessee may, on consent of the Secretary of the Interior first had and obtained, surrender and terminate this lease upon payment of all rents, royalties, and other debts due and payable to the lessor and upon payment of all wages or moneys due and payable to the workmen employed by the lessee, and upon a satisfactory showing to the Secretary of the Interior that the public interest will not be impaired; and the lessee may with like consent surrender any legal subdivision of the area included within the lease; but in no case shall such termination be effective until the lessee shall have made provision for the preservation of any mines or productive works or permanent improvements on the lands covered hereby.

(*6c*) That on the termination of this lease, pursuant to the last preceding paragraph, the lessor, his agent, licensee, or lessee shall have the exclusive right at the lessor's election to purchase at any time within six months thereafter, at the appraised value, any or all buildings, machinery, tools, or other property placed by the lessee in or on the lands leased hereunder, save and except all underground timber and such other supports and structures as are necessary for the protection and preservation of the mine, which shall be and remain a part of the realty without further consideration or compensation; that the purchase price to be paid for said buildings, machinery, equipment, tools, or other property to be purchased as aforesaid shall be fixed by appraisal of three disinterested and competent persons (one to be designated by each party hereto and the third to be selected by the two so designated), the valuation so determined by the three or a majority of them to be conclusive and binding upon both parties; that pending such election to purchase within the said period of six months none of the buildings or other property shall be removed from their normal position; that if such valuation be not requested or the lessor shall affirmatively, in writing, elect not to purchase within said period of six months, the lessee shall have the privilege of removing said buildings, machinery, equipment, tools, and other property within 90 days after being notified in writing by the lessor that the said lessor does not elect to purchase any or all of the buildings, machinery, equipment, tools, or other property, and in case of failure to so remove the said property within 90 days after receipt of such notice, then said buildings, machinery, tools, or other property shall become the property of the United States.

(*6d*) If the lessee shall fail to comply with the provisions of the act or make default in the performance or observance of any of the terms, covenants, and stipulations hereof, or of the general regulations promulgated and in force at date hereof, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the act, but this provision shall not be construed as depriving the lessor of any legal or equitable remedy which the lessor might otherwise have.

SECTION 7. It is further covenanted and agreed that, should the lessee fail to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of lessee.

SECTION 8. It is further covenanted and agreed that each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

SECTION 9. It is also further agreed that no member of or delegate to Congress, or resident commissioner, after his election or appointment, or either before or after he has qualified, and during his continuance in office, and that no officer, agent, or employee of the Department of the Interior, shall be admitted to any share or part in this lease, or derive any benefit that may arise therefrom, and the provisions of Section 3741 of the Revised Statutes of the United States and Sections 114, 115, and 116 of the Codification of the Penal Laws of the United States, approved March 4, 1909 (35 Stat. 1109), relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

IN WITNESS WHEREOF:

THE UNITED STATES OF AMERICA,

MAR - 1 1945

By Oscar L. Chapman
Assistant Secretary of the Interior, Lessor.

Thomas P. Greenhalgh
Lessee.

WITNESSES:

Charles W. Schoelzel Jr
376 Dexter Denver Colo

Denver, Colo
Frances Reilly

U.S. GOVERNMENT PRINTING OFFICE

16—30652-1

COAL LEASE D-034365
OF
W. R. GRACE AND COMPANY

(Original lease issued to Clifford G. Phelan, thence assigned to Colowyo Coal Company, and finally to W. R. Grace and Company.)

Russell
Wilkinson
Attys
J. Moran

4—696
(August 1912)

UNITED STATES
DEPARTMENT OF THE INTERIOR

MODIFIED

DISTRICT LAND OFFICE Denver

SERIAL NO. 034365

MINING LEASE OF COAL LANDS UNDER ACT OF FEBRUARY 25, 1920

This indenture of lease, entered into, in quintuplicate, this 25th day of October A. D. 1924, by and between the United States of America, acting in this behalf by the Assistant Secretary of the Interior, party of the first part, hereinafter called the lessor, and Clifford G. Phelan, of Axial, Colorado, party of the second part, hereinafter called the lessee, under, pursuant, and subject to the terms and provisions of the act of Congress, approved February 25, 1920 (41 Stat. 437), entitled "An act to promote the mining of coal, phosphate, oil, oil shale, gas, and sodium on the public domain," hereinafter called the "act."

WITNESSETH:

That the lessor, in consideration of the rents and royalties to be paid and the covenants to be observed as hereinafter set forth, does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in, upon, or under the following described tracts of land, situated in the State of Colorado, to wit: Lots 3, 4, 10, 13, 22, 23, SE¼NE¼, SW¼ sec. 2, T. 3 N., R. 93 W., 6th P. M., containing 310.69 acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

SECTION 1. That the lessor expressly reserves:

(1*a*) The right to permit for joint or several use such easements or rights of way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in said act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(1*b*) The right to lease, sell, or otherwise dispose of the surface of said lands or any part thereof under existing law or laws hereafter enacted, in so far as said surface is not necessary for the use of the lessee in the mining and removal of the coal therein, and to lease other mineral deposits in the lands, under the provisions of said act.

(1*c*) Full power and authority to carry out and enforce all the provisions of Section 30 of said act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly; and to safeguard the public welfare.

SECTION 2. The lessee in consideration of the lease of the rights and privileges aforesaid hereby covenants and agrees as follows:

(2*a*) To invest in actual mining operations, development, or improvements upon the land leased, or for the benefit thereof, the sum of five hundred dollars, ~~[illegible]~~ which is determined to have been expended.

(2*b*) To furnish a bond in the sum of $1,000.00 conditioned upon the expenditure of the amount specified in (2*a*) hereof and upon compliance with all the other terms of the lease. (In case of a $10,000 bond, a bond in the sum of $5,000 may be substituted after the investment requirement has been met.)

(2*c*) To pay as an annual rental for each acre or part thereof covered by this lease, the sum of 25 cents per acre for the first year, payment of which amount is hereby acknowledged, the sum of 50 cents per acre per year for the second, third, fourth, and fifth years, and $1 per acre for the sixth and each succeeding year during the life of

10—30452-1

I- 33 BI ✓

30

Posted Vol. 112/260 1/29/45 R.L.O.

this lease, all such annual payments of rental to be made to the register of the District Land Office of the district in which said land is situated, on the anniversary of the date hereof, and to be credited on the first royalties to become due hereunder during the year for which said rental was paid.

(2*d*) To pay to such register a royalty of ..15............ cents 10 cents on the new land on every ton of 2,000 pounds of coal mined during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

(2*e*) To determine accurately the weight of all coal mined from the leased premises, and to accurately enter the weight or weights thereof in due form in books to be kept and preserved by the lessee for such purpose.

(2*f*) To furnish quarterly, within 30 days after the expiration of the quarter, a written report covering such quarter, certified under oath by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the number of tons of 2,000 pounds of coal mined during the quarter, the character and quality thereof, amount of coal and products and by-products thereof disposed of and price received therefor, amount of coal and its products in storage or held for sale, and amount used in operations under this lease.

(2*g*) Also to furnish annually, and at such other times as the Secretary of the Interior may require, in the manner and form prescribed by the Secretary of the Interior, plat, map, or tracings showing all development work and improvements upon the leased lands, and other related information, with a report as to all buildings, structures, or other works placed in or upon the leased lands, a statement as to the amount and grade of coal produced and sold, and amount received therefor by operations hereunder, and, if a corporation, the amount of capital stock and list of its stockholders.

(2*h*) To keep at the mine office clear, accurate, and detailed maps, on a scale not more than 200 feet to the inch, in the form of horizontal projections on tracing cloth, of the workings in each coal bed in each separate mine on the leased lands, a separate map to be made for each such bed, and for the surface immediately over the underground workings, and to be so arranged with reference to a public land corner that the maps can be readily superimposed.

Each map of the workings in any coal bed shall show the thickness of the coal and of partings, and the dip and strike of each bed at intervals of 500 feet or less; the location of all openings connecting such bed with the workings in any other bed, or with any adjacent mine, or with the surface; the location of all entries, gangways, rooms, or breasts, and all other mine openings, shafts, airways, appliances, and devices, constructed or placed in the mine or any of the workings thereof; and such maps shall also show the elevation relative to sea level or a Government survey corner of the principal points of the various beds and workings.

Blue prints or reproductions in duplicate of the maps required as aforesaid shall be furnished the lessor when made, and supplemental prints or reproductions in duplicate furnished on or before the first day of each succeeding year, showing the extensions, additions, and changes since the last map or supplement was submitted. All mine progress maps kept by the lessee shall at all times be subject to examination by lessor.

(2*i*) That, beginning with the fourth year of the lease, except when such operation shall be interrupted by strikes, the elements, or casualties not attributable to the lessee, the lessee shall mine and pay a royalty on not less than ....5,000...... tons of coal per year, unless on application and showing made, operations shall be suspended for not exceeding six months at any one time, pursuant to section 7 of the act; or unless the lessee shall pay the royalty less rent, on such minimum amount of coal, for one year in advance, in which case operations may be suspended for that year.

(2*j*) That the lessee shall not assign this lease or any interest therein, nor sublet any portion of the leased premises without the written consent of the lessor being first had and obtained.

SECTION 3. It is mutually understood and agreed that the lessor shall have the right to readjust and fix the royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof, and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period, but in case the lessee be dissatisfied with the rate of royalty or other terms and conditions so fixed, he may terminate this lease in the manner and under the conditions provided in Sections 6 (*b*) and 6 (*c*) hereof.

D-034365

The lessee shall not discriminate against any employee or applicant for employment because of race, creed, color, or national origin, and shall require an identical provision to be included in all subcontracts.

SECTION 4. This lease is made subject to the following provisions, which the lessee accepts and covenants faithfully to perform and observe, unless the laws of the State where the leased land or deposits are situated otherwise provide, in which case such State laws control:

(4*a*) The lessee shall carry out and observe regulations prescribed by the Secretary of the Interior and in force at the date hereof relative to (1) reasonable diligence, skill, and care in the operation of said property in accordance with approved methods and practices; (2) the prevention of undue waste; (3) the safety and welfare of miners; and (4) insuring the fair and just weighing or measurement of the coal mined by each miner.

(4*b*) And also shall pay all miners and other employees, both above and below ground, at least twice each month in lawful money of the United States, and shall permit such miners and other employees full and complete freedom of purchase, but with a view to increasing safety this provision shall not apply to the purchase of explosives, detonators, or fuses; and shall not require or permit miners or other employees, except in case of emergency, to work underground for more than eight hours in any one workday, and shall not employ any boy under the age of 16 years, or any girl or woman without regard to age in any mine below the surface.

SECTION 5. And the lessee also expressly agrees that all mining and related operations shall be subject to the inspection of authorized representatives of the lessor, and that such representatives, with all proper and necessary assistants, may at all reasonable times enter into and upon the leased lands and survey and examine same and all surface and underground improvements, works, machinery, equipment, and operations.

(5*a*) And also shall permit the lessor to examine all books and records pertaining to operations under this lease, and to make copies of and extracts from any or all of same, if desired.

(5*b*) And also shall permit the lessor or its lessees or transferees, with the approval of the lessor, to make and use upon or under the leased lands any workings necessary for freeing any other mine from water or gas, or extinguishing fires, causing as little damage or interference as possible to or with the mine or mining operations of the lessee hereunder: *provided*, that any such use by a transferee or another lessee shall be conditioned upon the payment to the lessee hereunder of the amount of actual damages sustained thereby and adequate compensation for such use.

(5*c*) And also shall, at the termination of this lease, as the result of forfeiture thereof, pursuant to paragraph (6*d*), deliver up to the lessor the lands covered thereby, including all fixtures, machinery, improvements, and appurtenances, other than strictly personal property, situate on any of said lands, in good order and condition, so as to permit of immediate continued operation to the full extent and capacity of the leased premises.

SECTION 6. It is further mutually understood and agreed as follows:

(6*a*) That the lessor may, in writing, waive any breach of the covenants and conditions contained herein, except such as are required by the act, but any such waiver shall extend only to the particular breach so waived, and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

(6*b*) The lessee may, on consent of the Secretary of the Interior first had and obtained, surrender and terminate this lease upon payment of all rents, royalties, and other debts due and payable to the lessor and upon payment of all wages or moneys due and payable to the workmen employed by the lessee, and upon a satisfactory showing to the Secretary of the Interior that the public interest will not be impaired; and the lessee may with like consent surrender any legal subdivision of the area included within the lease; but in no case shall such termination be effective until the lessee shall have made provision for the preservation of any mines or productive works or permanent improvements on the lands covered hereby.

(6*c*) That on the termination of this lease, pursuant to the last preceding paragraph, the lessor, his agent, licensee, or lessee shall have the exclusive right at the lessor's election to purchase at any time within six months thereafter, at the appraised value, any or all buildings, machinery, tools, or other property placed by the lessee in or on the lands leased hereunder, save and except all underground timber and such other supports and structures as are necessary for the protection and preservation of the mine, which shall be and remain a part of the realty without further consideration or compensation: that the purchase price to be paid for said buildings, machinery, equipment, tools, or other property to be purchased as aforesaid shall be fixed by appraisal of three disinterested and competent persons (one to be designated by each party hereto and the third to be selected by the two so designated), the valuation so determined by the three or a majority of them to be conclusive and binding upon both parties: that pending such election to purchase within the said period of six months none of the buildings or other property shall be removed from their normal position: that if such valuation be not requested or the lessor shall affirmatively, in writing, elect not to purchase within said period of six months, the lessee shall have the privilege of removing said buildings, machinery, equipment, tools, and other property within 90 days after being notified in writing by the lessor that the said lessor does not elect to purchase any or all of the buildings, machinery, equipment, tools, or other property, and in case of failure to so remove the said property within 90 days after receipt of such notice, then said buildings, machinery, tools, or other property shall become the property of the United States.

(6*d*) If the lessee shall fail to comply with the provisions of the act or make default in the performance or observance of any of the terms, covenants, and stipulations hereof, or of the general regulations promulgated and in force at date hereof, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the act, but this provision shall not be construed as depriving the lessor of any legal or equitable remedy which the lessor might otherwise have.

SECTION 7. It is further covenanted and agreed that, should the lessee fail to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of lessee.

SECTION 8. It is further covenanted and agreed that each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

SECTION 9. It is also further agreed that no member of or delegate to Congress, or resident commissioner, after his election or appointment, or either before or after he has qualified, and during his continuance in office, and that no officer, agent, or employee of the Department of the Interior, shall be admitted to any share or part in this lease, or derive any benefit that may arise therefrom, and the provisions of Section 3741 of the Revised Statutes of the United States and Sections 114, 115, and 116 of the Codification of the Penal Laws of the United States, approved March 4, 1909 (35 Stat. 1109), relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

IN WITNESS WHEREOF:

THE UNITED STATES OF AMERICA,

JAN 24 1945 By Oscar L. Chapman
Assistant Secretary of the Interior, Lessor.

x Clifford G. Phelan
Lessee.

WITNESSES:

N. O. Marchant 704 Boston Bldg Denver, Colo

W. B. Cook Craig, Colo

U. S. GOVERNMENT PRINTING OFFICE 16—30532-1

SERIAL REGISTER PAGE

Legal Reference	File Code	Serial Number
Right-of-Way	2800	C-23377

Name and Mailing Address

Colowyo Coal Co., Div. of W. R. Grace & Co., Denver, CO
7935 E. Prentice, Bldg. 40

Description of Land

T. 4 N., R. 93 W., 6th P.M.
Sec 22: Lot 10
Sec 23: Lot 10
Sec 26: Lots 4, 8, 9
Sec 27: SE¼, S½NE¼
Sec 34: NE¼
Sec 35: Lots 3, 6, 8, 17, 18, NW¼, NW¼SW¼
T. 3 N., R. 93 W., 6th P.M.
Sec 2: Lots 3, 10, 13, 22, 23, NE¼SW¼
Sec 11: Northern 630, 94 feet of Lot 5

Moffat County

DATE OF ACTION	ACTION TAKEN
Dec 4, 1975	Received right-of-way application for the construction and use of a tramroad related to a coal mining operation across the above described lands.

Legal Description of National Resource Lands Applied for on Colowyo Mine Access Road Right-of-Way.

COAL LEASES C-081251
C-081258
C-0114093
OF
PEABODY COAL COMPANY

(United Electric Coal Companies has appointed Peabody the Designated Operator of Coal Leases C-081251 and C-081258. Sentry Royalty Company assigned Coal Lease C-0114093 to Peabody on February 5, 1968.)

Form 4–696
(January 1964)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

PREFERENCE-RIGHT COAL LEASE

Land Office
Colorado

Serial Number
C-081251

FILE
JM

This lease, entered into on the MAY 1 1965 day of , 19 , by the United States of America, the lessor, through the Bureau of Land Management, and **The United Electric Coal Companies**
307 North Michigan Avenue
Chicago 1, Illinois
, the lessee, pursuant and subject to the terms and provisions of the Act of February 25, 1920 (41 Stat. 437), as amended, hereinafter referred to as the Act, and to all reasonable regulations of the Secretary of the Interior now or hereafter in force which are made a part hereof,

RECEIVED
COLORADO LAND OFFICE
DENVER, COLORADO
1965 APR 21 PM 2 3

WITNESSETH:

Sec. 1. *Rights of Lessee.* The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in the following-described tracts of land, situated in the State of **Colorado,**

T. 5 N., R. 88 W., 6th P.M.
Sec. 3: Lot 5, SW¼NE¼, W½SE¼
Sec. 9: NW¼SE¼, S½SE¼
Sec. 10: All
Sec. 14: W½W½
Sec. 15: All
Sec. 20: E½E½
Sec. 21: N½
Sec. 22: N½

containing **2,519.03** acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

Sec. 2. In consideration of the foregoing, the lessee hereby agrees:

(a) Bond. To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all the provisions of the lease, and to increase the amount or furnish such other bond as may be required.

(b) Rental. To pay the lessor annually, in advance, for each acre or fraction thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents for the first year; 50 cents for the second, third, fourth, and fifth years, respectively; and $1 for the sixth and each succeeding year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

(c) Royalty. To pay the lessor a royalty of cents on every ton of 2,000 pounds of coal mined during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined. **(See Attached Royalty Schedule)**

(d) Minimum production. Beginning with the sixth year of the lease, *except* when operations are interrupted by strikes, the elements, or casualties not attributable to the lessee, or unless on application and showing made, operations shall be suspended when market conditions are such that the lessee cannot operate *except* at a loss or suspended for the other reasons specified in Section 39 of the Act, to mine coal each year and pay a royalty thereon to a value of $1 per acre or fraction thereof. Operations under this lease shall be continuous *except* in circumstances described or unless the lessee shall pay a royalty, less rent, on such minimum amount of the leased deposits, for one year in advance, in which case operations may be suspended for that year.

(e) Payments. To make rental payments to the Manager of the appropriate Land Office, *except* that when this lease becomes productive the rentals and

Case file

FILE
JM

ACC
ag 4-27-65

royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey, with whom all reports concerning operations under the lease shall be filed. All remittances to the Manager of the Land Office shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) Plats, reports, maps. At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined during the quarter, the character and quality thereof, amount of its products and byproducts disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with the appropriate regulations.

(g) Weights. To determine accurately the weight or quantity and quality of all leased deposits mined, and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) Inspection. To permit at all reasonable times (1) inspection by any duly authorized officer of the Department, of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) Assignment. To file for approval in the appropriate Land Office within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect the first day of the month following its approval by the Bureau of Land Management, or if the assignee requests, the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(j) Nondiscrimination clauses. During the performance of this contract the lessee agrees as follows:

(1) The lessee will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the lessee's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The lessee will comply with all provisions of Executive Order No. 10925 of March 6, 1961, as amended, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The lessee will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, as amended, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the lessee's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this lease may be cancelled, terminated, or suspended in whole or in part and the lessee may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The lessee will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order No. 10925 of March 6, 1961, as amended, so that such provisions will be binding upon each subcontractor or vendor. The lessee will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the lessee becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the lessee may request the United States to enter into such litigation to protect the interests of the United States.

(k) Land disposed of with coal deposits reserved to the United States. If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the deposits of coal therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

(l) Operations, wages, freedom of purchase. To comply with the appropriate operating regulations, to exercise reasonable diligence, skill, and care in the operations of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health or property, and of waste or damage to any water or mineral deposits; to fairly and justly weigh or measure the coal mined by each miner, to pay all wages due miners and employees, both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding eight hours in any one day for underground

ROYALTY SCHEDULE

For the first 10 years, a royalty rate of 15 cents a ton for coal mined by underground methods, and 17½ cents a ton for coal mined by strip or surface-auger mining methods, and for the remainder of the 20-year period a royalty rate of 17½ cents a ton for coal mined by underground methods, and 20 cents a ton for coal mined by strip or surface-auger mining methods.

Form 1510–11
(June 1964)
(formerly 4–1634)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

NONDISCRIMINATION IN EMPLOYMENT

During the performance of this contract the contractor agrees as follows:

(1) The contractor will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited, to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the contractor's commitments under this Section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The contractor will comply with all provisions of Executive Order Number 10925 of March 6, 1961, as amended, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The contractor will furnish all information and reports required by Executive Order Number 10925 of March 6, 1961, as amended, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order Number 10925 of March 6, 1961, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The contractor will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order Number 10925 of March 6, 1961, as amended, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

GPO 842-667

workers, except in cases of emergency; to employ no boy under the age of sixteen and no girl or woman, without regard to age, in any mine below the surface; unless the laws of the State otherwise provide, in which case the State laws control.

(m) Taxes. To pay when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(n) Overriding royalties. Not to create, by assignment or otherwise, an overriding royalty interest in excess of 50 percent of the rate of royalty first payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, excepting, that where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Bureau of Land Management, that he has made substantial investments for improvements on the land covered by the assignment.

(o) Delivery of premises in case of forfeiture. In case of forfeiture of this lease, to deliver up to the lessor in good order and condition the land leased, including all buildings, and underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit.

Sec. 3. The lessor expressly reserves:

(a) Rights reserved. The right to permit for joint or several use such easements or rights-of-way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) Disposition of surface. The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. Full power and authority to promulgate and enforce all the provisions of Section 30 of the Act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Readjustment of terms. The right reasonably to readjust and fix royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 20-year period, he will be deemed to have agreed to such terms.

(e) Waiver of conditions. The right to waive any breach of the conditions contained herein, *except* the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. *Relinquishment of lease.* Upon a satisfactory showing that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment *must* be filed in *duplicate* in the appropriate Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to make payment of all accrued rentals and royalties and to provide for the preservation of any mines or productive works or permanent improvements on the leased lands in accordance with the regulations and terms of the lease.

Sec. 5. *Protection of the surface, natural resources, and improvements.* The lessee agrees to take such reasonable steps as may be needed to prevent operations from unnecessarily: (1) causing or contributing to soil erosion or damaging any forage and timber growth thereon; (2) polluting the waters of springs, streams, wells, or reservoirs; (3) damaging crops, including forage, timber, or improvements of a surface owner; or (4) damaging range improvements whether owned by the United States or by its grazing permittees or lessees; and upon any partial or total relinquishment or the cancellation or expiration of this lease, or at any other time prior thereto when required by the lessor and to the extent deemed necessary by the lessor, to fill any sump holes, ditches and other excavations, remove or cover all debris, and, so far as reasonably possible, restore the surface of the leased land to its former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to lands of the United States and improvements thereon.

Sec. 6. *Removal of equipment, etc., on termination of lease.* Upon termination of this lease, by surrender or forfeiture, the lessee shall have the privilege at any time within a period of 90 days thereafter of removing from the premises all machinery, equipment, tools and materials, *except* underground timbering placed by the lessee in or on the leased lands, which are necessary for the preservation of the mine. Any materials, tools, appliances, machinery, structures, and equipment, subject to removal as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions, but the lessee shall remove any or all of such property where so directed by the lessor.

Sec. 7. *Proceedings in case of default.* If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or default in the performance or observance of any of the provisions of this lease, and such default shall continue for a period of 30 days after service of written notice thereof by the lessor, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee. However, the lessee shall

not be held responsible for delays or casualties occasioned by causes beyond the lessee's control.

Sec. 8. *Heirs and successors in interest.* Each obligation hereunder shall extend to, and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 9. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States, as amended (41 U.S.C. Sec. 22), and Sections 431, 432, and 433, Title 18, U.S.C., relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

NONDISCRIMINATION IN EMPLOYMENT

THIS CONTRACT (LEASE, LICENSE, PERMIT) IS SUBJECT TO THE PROVISIONS OF SEC. 301 OF EXECUTIVE ORDER NO. 10925, A COPY OF WHICH IS ATTACHED.

THE UNITED STATES OF AMERICA

By Lola M. Clark
(Signing Officer)

ASSISTANT MANAGER,
BRANCH OF MINERALS ADJUDICATION
(Title)

WITNESS TO SIGNATURE OF LESSEE

APR 22 1965
(Date)

THE UNITED ELECTRIC COAL COMPANIES
(Signature of Lessee)

Secretary

President
(Signature of Lessee)

(Signature of Lessee)

(If this lease is executed by a corporation, it must bear the corporate seal)

Form 4—696
(January 1964)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

RECEIVED
COLORADO LAND OFFICE
COLORADO

Land Office: **Colorado**

FILE

Serial Number: **C-081258**

PREFERENCE RIGHT COAL LEASE

1965 APR 21 PM 2 59

This lease, entered into on the MAY 1 1965 day of DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT 19 by the United States of America, the lessor, through the Bureau of Land Management, and

The United Electric Coal Companies
307 North Michigan Avenue
Chicago, Illinois 60601

, the lessee, pursuant and subject to the terms and provisions of the Act of February 25, 1920 (41 Stat. 437), as amended, hereinafter referred to as the Act, and to all reasonable regulations of the Secretary of the Interior now or hereafter in force which are made a part hereof,

WITNESSETH:

Sec. 1. *Rights of Lessee.* The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in the following-described tracts of land, situated in the State of **Colorado**

T. 5 N., R. 88 W., 6th P.M.
Sec. 23: All
Sec. 26: All
Sec. 27: NE¼, N½S½
Sec. 33: NE¼
Sec. 34: NW¼
Sec. 35: NE¼, Lots 3,4,5,6,11 and 12

containing **2,323.44** acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

Sec. 2. In consideration of the foregoing, the lessee hereby agrees:

(*a*) *Bond.* To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all the provisions of the lease, and to increase the amount or furnish such other bond as may be required.

(*b*) *Rental.* To pay the lessor annually, in advance, for each acre or fraction thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents for the first year; 50 cents for the second, third, fourth, and fifth years, respectively; and $1 for the sixth and each succeeding year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

(*c*) *Royalty.* To pay the lessor a royalty of cents on every ton of 2,000 pounds of coal mined during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

(See attached Royalty Schedule)

(*d*) *Minimum production.* Beginning with the sixth year of the lease, *except* when operations are interrupted by strikes, the elements, or casualties not attributable to the lessee, or unless on application and showing made, operations shall be suspended when market conditions are such that the lessee cannot operate *except* at a loss or suspended for the other reasons specified in Section 39 of the Act, to mine coal each year and pay a royalty thereon to a value of $1 per acre or fraction thereof. Operations under this lease shall be continuous *except* in circumstances described or unless the lessee shall pay a royalty, less rent, on such minimum amount of the leased deposits, for one year in advance, in which case operations may be suspended for that year.

(*e*) *Payments.* To make rental payments to the Manager of the appropriate Land Office, *except* that when this lease becomes productive the rentals and

se file ✓

FILE
IN

4-27

royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey, with whom all reports concerning operations under the lease shall be filed. All remittances to the Manager of the Land Office shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) Plats, reports, maps. At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined during the quarter, the character and quality thereof, amount of its products and byproducts disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with the appropriate regulations.

(g) Weights. To determine accurately the weight or quantity and quality of all leased deposits mined, and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) Inspection. To permit at all reasonable times (1) inspection by any duly authorized officer of the Department, of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) Assignment. To file for approval in the appropriate Land Office within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect the first day of the month following its approval by the Bureau of Land Management, or if the assignee requests, the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(j) Nondiscrimination clauses. During the performance of this contract the lessee agrees as follows:

(1) The lessee will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the lessee's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The lessee will comply with all provisions of Executive Order No. 10925 of March 6, 1961, as amended, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The lessee will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, as amended, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the lessee's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this lease may be cancelled, terminated, or suspended in whole or in part and the lessee may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The lessee will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order No. 10925 of March 6, 1961, as amended, so that such provisions will be binding upon each subcontractor or vendor. The lessee will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the lessee becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the lessee may request the United States to enter into such litigation to protect the interests of the United States.

(k) Land disposed of with coal deposits reserved to the United States. If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the deposits of coal therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

(l) Operations, wages, freedom of purchase. To comply with the appropriate operating regulations, to exercise reasonable diligence, skill, and care in the operations of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health or property, and of waste or damage to any water or mineral deposits; to fairly and justly weigh or measure the coal mined by each miner, to pay all wages due miners and employees, both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding eight hours in any one day for underground

ROYALTY SCHEDULE

For the first 10 years, a royalty rate of 15 cents a ton for coal mined by underground methods, and 17½ cents a ton for coal mined by strip or surface-auger mining methods, and for the remainder of the 20-year period a royalty rate of 17½ cents a ton for coal mined by underground methods, and 20 cents a ton for coal mined by strip or surface-auger mining methods.

Form 1510–11
(June 1964)
(formerly 4–1634)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

NONDISCRIMINATION IN EMPLOYMENT

During the performance of this contract the contractor agrees as follows:

(1) The contractor will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited, to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the contractor's commitments under this Section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The contractor will comply with all provisions of Executive Order Number 10925 of March 6, 1961, as amended, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The contractor will furnish all information and reports required by Executive Order Number 10925 of March 6, 1961, as amended, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order Number 10925 of March 6, 1961, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The contractor will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order Number 10925 of March 6, 1961, as amended, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

workers, except in cases of emergency; to employ no boy under the age of sixteen and no girl or woman, without regard to age, in any mine below the surface; unless the laws of the State otherwise provide, in which case the State laws control.

(m) Taxes. To pay when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(n) Overriding royalties. Not to create, by assignment or otherwise, an overriding royalty interest in excess of 50 percent of the rate of royalty first payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, excepting, that where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Bureau of Land Management, that he has made substantial investments for improvements on the land covered by the assignment.

(o) Delivery of premises in case of forfeiture. In case of forfeiture of this lease, to deliver up to the lessor in good order and condition the land leased, including all buildings, and underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit.

Sec. 3. The lessor expressly reserves:

(a) Rights reserved. The right to permit for joint or several use such easements or rights-of-way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) Disposition of surface. The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. Full power and authority to promulgate and enforce all the provisions of Section 30 of the Act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Readjustment of terms. The right reasonably to readjust and fix royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 20-year period, he will be deemed to have agreed to such terms.

(e) Waiver of conditions. The right to waive any breach of the conditions contained herein, *except* the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. *Relinquishment of lease.* Upon a satisfactory showing that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment *must* be filed in *duplicate* in the appropriate Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to make payment of all accrued rentals and royalties and to provide for the preservation of any mines or productive works or permanent improvements on the leased lands in accordance with the regulations and terms of the lease.

Sec. 5. *Protection of the surface, natural resources, and improvements.* The lessee agrees to take such reasonable steps as may be needed to prevent operations from unnecessarily: (1) causing or contributing to soil erosion or damaging any forage and timber growth thereon; (2) polluting the waters of springs, streams, wells, or reservoirs; (3) damaging crops, including forage, timber, or improvements of a surface owner; or (4) damaging range improvements whether owned by the United States or by its grazing permittees or lessees; and upon any partial or total relinquishment or the cancellation or expiration of this lease, or at any other time prior thereto when required by the lessor and to the extent deemed necessary by the lessor, to fill any sump holes, ditches and other excavations, remove or cover all debris, and, so far as reasonably possible, restore the surface of the leased land to its former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to lands of the United States and improvements thereon.

Sec. 6. *Removal of equipment, etc., on termination of lease.* Upon termination of this lease, by surrender or forfeiture, the lessee shall have the privilege at any time within a period of 90 days thereafter of removing from the premises all machinery, equipment, tools and materials, *except* underground timbering placed by the lessee in or on the leased lands, which are necessary for the preservation of the mine. Any materials, tools, appliances, machinery, structures, and equipment, subject to removal as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions, but the lessee shall remove any or all of such property where so directed by the lessor.

Sec. 7. *Proceedings in case of default.* If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or default in the performance or observance of any of the provisions of this lease, and such default shall continue for a period of 30 days after service of written notice thereof by the lessor, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee. However, the lessee shall

not be held responsible for delays or casualties occasioned by causes beyond the lessee's control.

Sec. 8. *Heirs and successors in interest.* Each obligation hereunder shall extend to, and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 9. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States, as amended (41 U.S.C. Sec. 22), and Sections 431, 432, and 433, Title 18, U.S.C., relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

NONDISCRIMINATION IN EMPLOYMENT

THIS CONTRACT (LEASE, LICENSE, PERMIT) IS SUBJECT TO THE PROVISIONS OF SEC. 301 OF EXECUTIVE ORDER NO. 10925, A COPY OF WHICH IS ATTACHED.

THE UNITED STATES OF AMERICA

By Lola M. Clark
(Signing Officer)

ASSISTANT MANAGER,
BRANCH OF MINERALS ADJUDICATION
(Title)

WITNESS TO SIGNATURE OF LESSEE

APR 22 1965
(Date)

THE UNITED ELECTRIC COAL COMPANIES
(Signature of Lessee)

Secretary

x
President
(Signature of Lessee)

(Signature of Lessee)

(If this lease is executed by a corporation, it must bear the corporate seal)

Form 4–696
(January 1964)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

COAL LEASE

Land Office Colorado	FILE
Serial Number C-0114093	

clark

This lease, entered into on the day of **MAY 1** , 1964 , by the United States of America, the lessor, through the Bureau of Land Management, and

Sentry Royalty Company
301 Olive Street
St. Louis, Missouri 63102

, the lessee, pursuant and subject to the terms and provisions of the Act of February 25, 1920 (41 Stat. 437), as amended, hereinafter referred to as the Act, and to all reasonable regulations of the Secretary of the Interior now or hereafter in force which are made a part hereof,

WITNESSETH:

Sec. 1. *Rights of Lessee.* The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in the following-described tracts of land, situated in the State of Colorado.

T. 5 N., R. 87 W., 6th P.M.
Sec. 17: S½, SW¼NE¼, SE¼NW¼, W½NW¼
Sec. 18: E½E½, SW¼SE¼
Sec. 19: E½NW¼, NE¼, W½SE¼
Sec. 20: NW¼, W½SW¼
Sec. 29: NW¼NW¼
Sec. 30: NE¼NE¼

F

containing 1320 acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

Sec. 2. In consideration of the foregoing, the lessee hereby agrees:

(a) Bond. To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all the provisions of the lease, and to increase the amount or furnish such other bond as may be required.

(b) Rental. To pay the lessor annually, in advance, for each acre or fraction thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents for the first year; 50 cents for the second, third, fourth, and fifth years, respectively; and $1 for the sixth and each succeeding year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

(c) Royalty. To pay the lessor a royalty of 30 days from the expiration of the quarter in which the coal is mined. *(See attached Royalty rate)

(d) Minimum production. Beginning with the sixth year of the lease, *except* when operations are interrupted by strikes, the elements, or casualties not attributable to the lessee, or unless on application and showing made, operations shall be suspended when market conditions are such that the lessee cannot operate *except* at a loss or suspended for the other reasons specified in Section 39 of the Act, to mine coal each year and pay a royalty thereon to a value of $1 per acre or fraction thereof. Operations under this lease shall be continuous *except* in circumstances described or unless the lessee shall pay a royalty, less rent, on such minimum amount of the leased deposits, for one year in advance, in which case operations may be suspended for that year.

* (c) Royalty. The royalty is 15 cents a ton of 2,000 pounds mine run for coal mined by underground methods and 17½ cents a ton for coal mined by strip mining or surface auger mining methods.

royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey, with whom all reports concerning operations under the lease shall be filed. All remittances to the Manager of the Land Office shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) Plats, reports, maps. At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined during the quarter, the character and quality thereof, amount of its products and byproducts disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with the appropriate regulations.

(g) Weights. To determine accurately the weight or quantity and quality of all leased deposits mined, and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) Inspection. To permit at all reasonable times (1) inspection by any duly authorized officer of the Department, of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) Assignment. To file for approval in the appropriate Land Office within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect the first day of the month following its approval by the Bureau of Land Management, or if the assignee requests, the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(j) Nondiscrimination clauses. During the performance of this contract the lessee agrees as follows:

(1) The lessee will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the lessee's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The lessee will comply with all provisions of Executive Order No. 10925 of March 6, 1961, as amended, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The lessee will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, as amended, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the lessee's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this lease may be cancelled, terminated, or suspended in whole or in part and the lessee may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The lessee will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order No. 10925 of March 6, 1961, as amended, so that such provisions will be binding upon each subcontractor or vendor. The lessee will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the lessee becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the lessee may request the United States to enter into such litigation to protect the interests of the United States.

(k) Land disposed of with coal deposits reserved to the United States. If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the deposits of coal therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

(l) Operations, wages, freedom of purchase. To comply with the appropriate operating regulations, to exercise reasonable diligence, skill, and care in the operations of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health or property, and of waste or damage to any water or mineral deposits; to fairly and justly weigh or measure the coal mined by each miner, to pay all wages due miners and employees, both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding eight hours in any one day for underground

workers, except in cases of emergency; to employ no boy under the age of sixteen and no girl or woman, without regard to age, in any mine below the surface; unless the laws of the State otherwise provide, in which case the State laws control.

(m) Taxes. To pay when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(n) Overriding royalties. Not to create, by assignment or otherwise, an overriding royalty interest in excess of 50 percent of the rate of royalty first payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, excepting, that where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Bureau of Land Management, that he has made substantial investments for improvements on the land covered by the assignment.

(o) Delivery of premises in case of forfeiture. In case of forfeiture of this lease, to deliver up to the lessor in good order and condition the land leased, including all buildings, and underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit.

Sec. 3. The lessor expressly reserves:

(a) Rights reserved. The right to permit for joint or several use such easements or rights-of-way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) Disposition of surface. The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. Full power and authority to promulgate and enforce all the provisions of Section 30 of the Act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Readjustment of terms. The right reasonably to readjust and fix royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 20-year period, he will be deemed to have agreed to such terms.

(e) Waiver of conditions. The right to waive any breach of the conditions contained herein, *except* the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. *Relinquishment of lease.* Upon a satisfactory showing that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment *must* be filed in *duplicate* in the appropriate Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to make payment of all accrued rentals and royalties and to provide for the preservation of any mines or productive works or permanent improvements on the leased lands in accordance with the regulations and terms of the lease.

Sec. 5. *Protection of the surface, natural resources, and improvements.* The lessee agrees to take such reasonable steps as may be needed to prevent operations from unnecessarily: (1) causing or contributing to soil erosion or damaging any forage and timber growth thereon; (2) polluting the waters of springs, streams, wells, or reservoirs; (3) damaging crops, including forage, timber, or improvements of a surface owner; or (4) damaging range improvements whether owned by the United States or by its grazing permittees or lessees; and upon any partial or total relinquishment or the cancellation or expiration of this lease, or at any other time prior thereto when required by the lessor and to the extent deemed necessary by the lessor, to fill any sump holes, ditches and other excavations, remove or cover all debris, and, so far as reasonably possible, restore the surface of the leased land to its former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to lands of the United States and improvements thereon.

Sec. 6. *Removal of equipment, etc., on termination of lease.* Upon termination of this lease, by surrender or forfeiture, the lessee shall have the privilege at any time within a period of 90 days thereafter of removing from the premises all machinery, equipment, tools and materials, *except* underground timbering placed by the lessee in or on the leased lands, which are necessary for the preservation of the mine. Any materials, tools, appliances, machinery, structures, and equipment, subject to removal as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions, but the lessee shall remove any or all of such property where so directed by the lessor.

Sec. 7. *Proceedings in case of default.* If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or default in the performance or observance of any of the provisions of this lease, and such default shall continue for a period of 30 days after service of written notice thereof by the lessor, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee. However, the lessee shall

not be held responsible for delays or casualties occasioned by causes beyond the lessee's control.

Sec. 8. *Heirs and successors in interest.* Each obligation hereunder shall extend to, and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 9. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States, as amended (41 U.S.C. Sec. 22), and Sections 431, 432, and 433, Title 18, U.S.C., relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

NONDISCRIMINATION IN EMPLOYMENT

THIS CONTRACT (LEASE, LICENSE, PERMIT) IS SUBJECT TO THE PROVISIONS OF SEC. 301 OF EXECUTIVE ORDER NO. 10925, A COPY OF WHICH IS ATTACHED.

THE UNITED STATES OF AMERICA

By ______________________
(Signing Officer)

TPS APR 14 '64 - mo

Land Office Manager
(Title)

April 13, 1964
(Date)

WITNESS TO SIGNATURE OF LESSEE

ATTEST:

Assistant Secretary

SENTRY ROYALTY COMPANY

By: C. E. Stokes, Vice-Pres
(Signature of Lessee)

Irma D. Onken

(Signature of Lessee)

(Signature of Lessee)

(If this lease is executed by a corporation, it must bear the corporate seal)

Form 4—1634
(April 1962)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

NONDISCRIMINATION IN EMPLOYMENT

In connection with the performance of work under this contract, the Contractor agrees as follows:

(1) The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Contracting Officer setting forth the provisions of this nondiscrimination clause.

(2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The Contractor will send to each labor union or representative of workers with which he has a collective-bargaining agreement or other contract or understanding, a notice, to be provided by the agency Contracting Officer, advising the said labor union or workers' representative of the Contractor's commitments under this nondiscrimination clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Contractor will comply with all provisions of Executive Order No. 10925 of March 6, 1961, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The Contractor will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the Contractor's noncompliance with the nondiscrimination clause of this contract or with any of the said rules, regulations, or orders, this contract may be canceled in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The Contractor will include the provisions of the foregoing paragraphs (1) through (6) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to section 303 of Executive Order No. 10925 of March 6, 1961, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

NOTE TO CONTRACTOR

Additional requirement for subcontracts with the Department of the Interior.

In compliance with the Rules and Regulations (41 CFR, section 60–1.3(a)) issued under Executive Order 10925 of March 6, 1961, the prime contractor is hereby bound and agrees to include in each subcontract which it shall make with a subcontractor or supplier paragraphs (1) through (7) of section 301 of said Executive Order (as quoted above), unless exempted pursuant to the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity.

GPO 855220

GPO 832077

COAL LEASE D-051698
OF
RUBY CONSTRUCTION COMPANY, INC.

(Original lease issued to Thomas E. Barton and subsequently assigned to Ruby Construction Co.)

Berger

4—696

UNITED STATES
DEPARTMENT OF THE INTERIOR

U. S. LAND OFFICE AT Denver

SERIAL NO. 051698

MINING LEASE OF COAL LANDS UNDER ACT OF FEBRUARY 25, 1920

This indenture of lease, entered into, in quintuplicate, this 11th day of September, A. D. 1941, by and between the United States of America, acting in this behalf by the First Assistant Secretary of the Interior, party of the first part, hereinafter called the lessor, and Thomas E. Marton, of Mt. Morrison, Colorado, party of the second part, hereinafter called the lessee, under, pursuant, and subject to the terms and provisions of the act of Congress, approved February 25, 1920 (41 Stat. 437), entitled "An act to promote the mining of coal, phosphate, oil, oil shale, gas, and sodium on the public domain," hereinafter called the "act."

WITNESSETH:

That the lessor, in consideration of the rents and royalties to be paid and the covenants to be observed as hereinafter set forth, does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in, upon, or under the following described tracts of land, situated in the State of Colorado, to wit: lots 2, 3, 4 Sec. 12, T. 4 N., R. 89 W., 6th P. M., containing 146.26 acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

SECTION 1. That the lessor expressly reserves:

(1*a*) The right to permit for joint or several use such easements or rights of way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in said act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(1*b*) The right to lease, sell, or otherwise dispose of the surface of said lands or any part thereof under existing law or laws hereafter enacted, in so far as said surface is not necessary for the use of the lessee in the mining and removal of the coal therein, and to lease other mineral deposits in the lands, under the provisions of said act.

(1*c*) Full power and authority to carry out and enforce all the provisions of Section 30 of said act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly; and to safeguard the public welfare.

SECTION 2. The lessee in consideration of the lease of the rights and privileges aforesaid hereby covenants and agrees as follows:

(2*a*) To invest in actual mining operations, development, or improvements upon the land leased, or for the benefit thereof, the sum of two thousand dollars, of which sum not less than one-third shall be so expended during the first year succeeding the execution of this instrument and a like sum each of the two succeeding years, unless sooner expended; and submit annually, at the expiration of each year for the said period, an itemized statement of the amount and character of said expenditure during such year.

(2*b*) To furnish a bond in the sum of $1,000.00 conditioned upon the expenditure of the amount specified in (2*a*) hereof and upon compliance with all the other terms of the lease. (In case of a $10,000 bond, a bond in the sum of $5,000 may be substituted after the investment requirement has been met.)

(2*c*) To pay as an annual rental for each acre or part thereof covered by this lease, the sum of 25 cents per acre for the first year, payment of which amount is hereby acknowledged, the sum of 50 cents per acre per year for the second, third, fourth, and fifth years, and $1 per acre for the sixth and each succeeding year during the life of

4—7088

Posted 9-29-41 Vol 110/136 & T/T/O

this lease, all such annual payments of rental to be made to the register of the United States Land Office of the district in which said land is situated. on the anniversary of the date hereof, and to be credited on the first royalties to become due hereunder during the year for which said rental was paid.

(2*d*) To pay to such register a royalty of ......15.......... cents on every ton of 2,000 pounds of coal mined during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

(2*e*) To determine accurately the weight of all coal mined from the leased premises, and to accurately enter the weight or weights thereof in due form in books to be kept and preserved by the lessee for such purpose.

(2*f*) To furnish quarterly, within 30 days after the expiration of the quarter, a written report covering such quarter, certified under oath by the superintendent of the mine. or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose. showing the number of tons of 2,000 pounds of coal mined during the quarter, the character and quality thereof, amount of coal and products and by-products thereof disposed of and price received therefor, amount of coal and its products in storage or held for sale, and amount used in operations under this lease.

(2*g*) Also to furnish annually, and at such other times as the Secretary of the Interior may require, in the manner and form prescribed by the Secretary of the Interior. plat, map. or tracings showing all development work and improvements upon the leased lands. and other related information, with a report as to all buildings, structures, or other works placed in or upon the leased lands. a statement as to the amount and grade of coal produced and sold, and amount received therefor by operations hereunder, and, if a corporation, the amount of capital stock and list of its stockholders.

(2*h*) To keep at the mine office clear. accurate, and detailed maps, on a scale not more than 200 feet to the inch, in the form of horizontal projections on tracing cloth. of the workings in each coal bed in each separate mine on the leased lands, a separate map to be made for each such bed. and for the surface immediately over the underground workings, and to be so arranged with reference to a public land corner that the maps can be readily superimposed.

Each map of the workings in any coal bed shall show the thickness of the coal and of partings, and the dip and strike of each bed at intervals of 500 feet or less; the location of all openings connecting such bed with the workings in any other bed, or with any adjacent mine. or with the surface: the location of all entries, gangways, rooms, or breasts. and all other mine openings. shafts. airways. appliances. and devices, constructed or placed in the mine or any of the workings thereof: and such maps shall also show the elevation relative to sea level or a Government survey corner of the principal points of the various beds and workings.

Blue prints or reproductions in duplicate of the maps required as aforesaid shall be furnished the lessor when made, and supplemental prints or reproductions in duplicate furnished on or before the first day of each succeeding year. showing the extensions, additions, and changes since the last map or supplement was submitted. All mine progress maps kept by the lessee shall at all times be subject to examination by lessor.

(2*i*) That, beginning with the fourth year of the lease, except when such operation shall be interrupted by strikes, the elements, or casualties not attributable to the lessee, the lessee shall mine and pay a royalty on not less than ....980.......... tons of coal per year, unless on application and showing made, operations shall be suspended for not exceeding six months at any one time. pursuant to section 7 of the act; or unless the lessee shall pay the royalty less rent, on such minimum amount of coal. for one year in advance, in which case operations may be suspended for that year.

(2*j*) That the lessee shall not assign this lease or any interest therein, nor sublet any portion of the leased premises without the written consent of the lessor being first had and obtained.

SECTION 3. It is mutually understood and agreed that the lessor shall have the right to readjust and fix the royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof, and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. but in case the lessee be dissatisfied with the rate of royalty or other terms and conditions so fixed, he may terminate this lease in the manner and under the conditions provided in Sections 6 (*b*) and 6 (*c*) hereof.

6—7966

Section 4. This lease is made subject to the following provisions, which the lessee accepts and covenants faithfully to perform and observe, unless the laws of the State where the leased land or deposits are situated otherwise provide, in which case such State laws control:

(*4a*) The lessee shall carry out and observe regulations prescribed by the Secretary of the Interior and in force at the date hereof relative to (1) reasonable diligence, skill, and care in the operation of said property in accordance with approved methods and practices; (2) the prevention of undue waste; (3) the safety and welfare of miners; and (4) insuring the fair and just weighing or measurement of the coal mined by each miner.

(*4b*) And also shall pay all miners and other employees, both above and below ground, at least twice each month in lawful money of the United States, and shall permit such miners and other employees full and complete freedom of purchase, but with a view to increasing safety this provision shall not apply to the purchase of explosives, detonators, or fuses; and shall not require or permit miners or other employees, except in case of emergency, to work underground for more than eight hours in any one workday, and shall not employ any boy under the age of 16 years, or any girl or woman without regard to age in any mine below the surface.

Section 5. And the lessee also expressly agrees that all mining and related operations shall be subject to the inspection of authorized representatives of the lessor, and that such representatives, with all proper and necessary assistants, may at all reasonable times enter into and upon the leased lands and survey and examine same and all surface and underground improvements, works, machinery, equipment, and operations.

(*5a*) And also shall permit the lessor to examine all books and records pertaining to operations under this lease, and to make copies of and extracts from any or all of same, if desired.

(*5b*) And also shall permit the lessor or its lessees or transferees, with the approval of the lessor, to make and use upon or under the leased lands any workings necessary for freeing any other mine from water or gas, or extinguishing fires, causing as little damage or interference as possible to or with the mine or mining operations of the lessee hereunder; *provided*, that any such use by a transferee or another lessee shall be conditioned upon the payment to the lessee hereunder of the amount of actual damages sustained thereby and adequate compensation for such use.

(*5c*) And also shall, at the termination of this lease, as the result of forfeiture thereof, pursuant to paragraph (*6d*), deliver up to the lessor the lands covered thereby, including all fixtures, machinery, improvements, and appurtenances, other than strictly personal property, situate on any of said lands, in good order and condition, so as to permit of immediate continued operation to the full extent and capacity of the leased premises.

Section 6. It is further mutually understood and agreed as follows:

(*6a*) That the lessor may, in writing, waive any breach of the covenants and conditions contained herein, except such as are required by the act, but any such waiver shall extend only to the particular breach so waived, and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

(*6b*) The lessee may, on consent of the Secretary of the Interior first had and obtained, surrender and terminate this lease upon payment of all rents, royalties, and other debts due and payable to the lessor and upon payment of all wages or moneys due and payable to the workmen employed by the lessee, and upon a satisfactory showing to the Secretary of the Interior that the public interest will not be impaired; and the lessee may with like consent surrender any legal subdivision of the area included within the lease; but in no case shall such termination be effective until the lessee shall have made provision for the preservation of any mines or productive works or permanent improvements on the lands covered hereby.

(*6c*) That on the termination of this lease, pursuant to the last preceding paragraph, the lessor, his agent, licensee, or lessee shall have the exclusive right at the lessor's election to purchase at any time within six months thereafter, at the appraised value, any or all buildings, machinery, tools, or other property placed by the lessee in or on the lands leased hereunder, save and except all underground timber and such other supports and structures as are necessary for the protection and preservation of the mine, which shall be and remain a part of the realty without further consideration or compensation; that the purchase price to be paid for said buildings, machinery, equipment, tools, or other property to be purchased as aforesaid shall be fixed by appraisal of three disinterested and competent persons (one to be designated by each party hereto and the third to be selected by the two so designated), the valuation so determined by the three or a majority of them to be conclusive and binding upon both parties: that pending such election to purchase within the said period of six months none of the buildings or other property shall be removed from their normal position; that if such valuation be not requested or the lessor shall affirmatively, in writing, elect not to purchase within said period of six months, the lessee shall have the privilege of removing said buildings, machinery, equipment, tools, and other property within 90 days after being notified in writing by the lessor that the said lessor does not elect to purchase any or all of the buildings, machinery, equipment, tools, or other property, and in case of failure to so remove the said property within 90 days after receipt of such notice, then said buildings, machinery, tools, or other property shall become the property of the United States.

(6*d*) If the lessee shall fail to comply with the provisions of the act or make default in the performance or observance of any of the terms, covenants, and stipulations hereof, or of the general regulations promulgated and in force at date hereof, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the act, but this provision shall not be construed as depriving the lessor of any legal or equitable remedy which the lessor might otherwise have.

Section 7. It is further covenanted and agreed that, should the lessee fail to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of lessee.

Section 8. It is further covenanted and agreed that each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Section 9. It is also further agreed that no member of or delegate to Congress, or resident commissioner, after his election or appointment, or either before or after he has qualified, and during his continuance in office, and that no officer, agent, or employee of the Department of the Interior, shall be admitted to any share or part in this lease, or derive any benefit that may arise therefrom, and the provisions of Section 3741 of the Revised Statutes of the United States and Sections 114, 115, and 116 of the Codification of the Penal Laws of the United States, approved March 4, 1909 (35 Stat. 1109), relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

In witness whereof:

THE UNITED STATES OF AMERICA,

By Oscar L. Chapman

~~First~~ *Assistant Secretary of the Interior, Lessor.*

Thos. E. Barton

Lessee.

Witnesses:

S. J. Scott, Denv, Colo.

J. Frances Reilly Denver, Colo

U.S. GOVERNMENT PRINTING OFFICE: 1936

6—7908

Leases

TABLE I-1

Preference Right Lease Applications in Study Region

Applicant	Serial Number	Date of App. for Prospecting Permit	Acreage	Map Number
L. C. Craig	C 0125366	5-05-65	640.00	104
Ember Mining Co.	C 0126997	1-17-66	3,566.38	99
Ember Mining Co.	C 0126998	1-17-66	5,099.31	100
Ember Mining Co.	C 0126999	1-17-66	960.00	101
Phil Jenson & K. W. Miller	C 4275	6-20-68	2,071.76	98
Kemmerer Coal Co.	C 3606	3-12-68	2,984.17	78
Kemmerer Coal Co.	C 3605	3-12-68	2,984.44	79
Moonlake Electric Assoc.	C 8424	2-20-69	2,552.32	105
Moonlake Electric Assoc.	C 8425	2-20-69	560.00	106
Staley-Gordon Coal Co., Inc.	C 0126669	12-15-65	259.06	107
Utah International, Inc.	C 0123475	8-19-64	2,081.51	57
Total Acreage			23,758.95	

Recoverable Reserves (million tons): Strippable 59.57
Underground 686.16

Total 745.73

Map Number refers to number designation on the Surface-Minerals Management Quads in Appendix A.

Leases

TABLE I-2

Competitive Lease Applications in Study Regions

Applicant	Serial Number	Application Date	Acreage	Map Number
Coal Fuels Corp.	C 22546	3-20-75	6,960.00	110
Empire Energy Corp.	C 14738	12-17-71	7,105.00	49
Empire Energy Corp.	C 13134	6-18-71	240.00	55
Empire Energy Corp.	C 21981	9-17-74	974.07	3
Morgan Coal Co.	C 16284 [1]	5-10-72	120.00	35
Energy Fuels Corp.	C 20900 [1]	5-24-74	419.87	34
Morgan Coal Co.	C 9968	11-10-69	320.00	68
James C. Goodwin	C 3440	1-30-68	604.75	14
Gossard, Inc.	C 16618	7-14-72	6,200.00	56
Peabody Coal Co.	C 19855 [1]	12-17-73	125.16	59
Moonlake Electric Assoc.	C 22654	4-30-75	12,680.00	111
Energy Fuels Corp.	C 22644	4-30-75	678.01	112
Halandras Brothers	C 22628	4-21-75	640.00	113
Energy Fuels Corp.	C 22677	4-30-75	604.26	114
W. R. Grace & Co.	C 22836	7-11-75	496.64	
W. R. Grace & Co.	C 22837	7-11-75	2,604.46	
W. R. Grace & Co.	C 22838	7-11-75	1,787.67	
W. R. Grace & Co.	C 22839	7-11-75	379.56	
James D. Tatum	C 23055	9-16-75	[2]	
P. A. Burton	C 23081	10-20-75	11,250.68	
J. R. Roller & Assoc.	C 23082	9-22-75	619.53	
James D. Tatum	C 23096	9-25-75	[2]	
Energy Fuels	C 22676 [1]	4-30-75	723.81	115
Peabody Coal Co.	C 22786	6-23-75	200.00	117
Utah International	C 3506	2-12-68	4,780.38	46
Empire Energy	C 14737	12-17-71	12,647.84	1
Empire Energy	C 14739	12-17-71	341.00	116
Commonwealth Coal	C 15846	3-07-72	480.00	109
Total Acreage			73,982.69	

[1] Meet the Secretary's short-term leasing criteria; addressed as site specific analysis in Northwest Colorado Coal EIS. Due to lack of data, C 19855 may require additional environmental reporting.

[2] No acreage data because of improper application. Not included in total.

Map Number refers to number designation on the Surface-Minerals Management Quads in Appendix A.

If no map number is shown, application was received after map was printed.

Leases

TABLE I-3

Issued Preference Right Leases in Study Region

Lessee	Serial Number	Map Number	Acreage	Application Date	Issuance Date	Expiration Date	Cumulative Production (1,000 tons)	Cumulative Rentals Royalties, and Bonuses
American Fuels Corp.	C 076713	94	320	1-17-62	2-1-66	2-1-86	26	4,100
Consolidation Coal Co.	C 093713	89	2,517.98	10-16-62	6-1-67	6-1-87		10,700
Consolidation Coal Co.	C 093714	90	1,458.00	10-16-62	6-1-67	6-1-87		6,200
Consolidation Coal Co.	C 093715	91	1,760.00	10-16-62	6-1-67	6-1-87		7,500
Consolidation Coal Co.	C 093716	92	2,060.91	10-16-62	6-1-67	6-1-87		8,700
Morgan Coal Co.	C 081330	32	2,215.28	4-26-62	11-1-63	11-1-83	226	55,000
Ferne James	C 064416	52	40.10	5-17-61	1-1-66	1-1-86		200
Gulf Oil Corp. (Pittsburg-Midway)	C 021601	23	826.94	4-3-58	6-1-62	6-1-82		7,600
Peabody Coal Co. (Mat. Serv. Corp.)	C 081251 [1]	39	2,519.03	4-4-62	5-1-65	5-1-85		15,700
Peabody Coal Co. (Mat. Serv. Corp.)	C 081258 [1]	40	2,323.44	4-6-62	5-1-65	5-1-85		14,500
Joe Petranovich (Routt Mining Co.)	D 052546	25	160	10-20-43	9-27-48	9-27-88	2	3,600
Paul Riebold	C 028875	102	1,675.22	5-7-59	11-1-63	11-1-83		13,800
Franklin Real Estate (Amer. Elec. Power)	C 012894	31	634.42	12-22-55	12-1-56	12-1-76	431	68,600
Utah International, Inc.	C 07519	44	1,371.82	11-24-53	6-1-58	6-1-78		19,800
Utah International, Inc.	C 07518	45	2,566.44	11-24-53	6-1-58	6-1-78		31,500
Utah International, Inc.	C 813	48	159.55	11-3-66	4-1-70	4-1-90		400
Utah International, Inc.	C 0123476	58	2,255.22	8-19-64	12-1-66	12-1-86		11,800
Morgan Coal	C 0128433 [1]	33	474.93	6-22-66	6-1-75	6-1-95		
Moonlake Electric	C 023703	108	2,557.22	8-21-58	3-1-63	3-1-83		23,600
Totals			27,896.50				685	303,300

Recoverable Reserves (MM tons):	
Strippable	115.61
Underground	422.44
Total	538.05

Note: [1] Addressed as a site-specific analysis in the Northwest Colorado Coal EIS.
"Map Number" refers to number designation on the Surface-Minerals Management Quads in Appendix A.
"Application Date" is the date of application for pros.
"Issuance Date" is the date of original lease issuance.
"Expiration Date" is that next upcoming.

Leases

TABLE I-4

Issued Competitive Leases in Study Region

Lessee	Serial Number	Map Number	Acreage	Application Date	Issuance Date	Expiration Date	Cumulative Production (1,000 tons)	Cumulative Rentals Royalties, and Bonuses
Consolidation Coal Co.	C 245	62	225.86	8-2-66 3/	10-1-66	10-1-86		1,900
Consolidation Coal Co.	C 1545	87	896.07	7-19-67 3/	9-1-67	9-1-87		5,600
Consolidation Coal Co.	C 1546	88	1,096.73	7-19-67 3/	9-1-67	9-1-87		7,200
Commonwealth Coal Co.	D 044240	93	160.00	8-5-31	1-12-33	1/	126	20,800
Empire Energy Corp.	D 056298	2	41.21	4-23-48	12-1-49	12-1-89	69	11,200
Empire Energy Corp.	C 0127865	4	43.03	4-11-66	11-1-66	11-1-86		200
Morgan Coal Co.	D 052547 2/	30	1,145.13	10-21-43	3-1-45	3-1-85	6,250	1,111,500
W. R. Grace	D 034365	20	2,564.73	4-8-24	10-25-24	10-25-84	3,413	440,400
Gulf Oil Corp. (Pittsburg-Midway)	D 041478	22	80.06	3-22-29	5-6-30	5-6-90	1,024	109,300
Gulf Oil Corp. (Pittsburg-Midway)	D 053710	24	89.04	12-12-45	6-10-47	6-10-87	172	27,400
Gulf Oil Corp. (Pittsburg-Midway)	D 033327	21	280.00	12-8-22	4-23-25	4-23-85	1,285	174,400
Maneotis Sheep Co.	D 051376	28	250.41	7-27-39	10-7-40	10-8-80	24	13,600
Peabody Coal Co.	C 088199	36	2,280.00	7-2-62	7-1-63	7-1-83	1,985	52,300
Peabody Coal Co.	C 086654	37	160.00	6-25-62	7-1-63	7-1-83	824	127,200
Peabody Coal Co.	C 0114093	38	1,320.00	10-21-63	5-1-64	5-1-84		24,100
Peabody Coal Co.	C 0125957	54	3,863.00	7-26-65	10-1-65	10-1-85		44,100
Reliable Coal	D 047201	103	513	1-23-35	7-25-36	6-25-76	182	29,600
Routt Mining Co.	C 0127592	26	80.00	3-7-66	10-1-66	10-1-86		800
Routt Mining Co.	D 046544	27	120.00	4-27-34	12-3-37	12-3-77	178	24,900
Utah International, Inc.	C 079641	43	1,351.84	3-21-62	10-1-62	10-1-82		13,900
Utah International, Inc.	C 0126480	47	366.51	11-15-65 3/	1-1-66	1-1-86		4,600
Ruby Construction	D 051698 2/	29	146.26	10-28-40	9-11-41	9-11-81	10	4,600
Totals			17,072.88				15,539	2,249,600

Recoverable Reserves: (MM tons)

Strippable	79.67
Underground	241.67
Total	321.28

Note:

1/ Lease renewal in litigation

2/ Addressed as a site-specific analysis in the Northwest Colorado Coal EIS

3/ Indicates sale date

"Issuance Date" is the date of original lease issuance.
"Expiration Date" is that next upcoming.
"Map Number" refers to number designation on the Surface-Minerals Management Quads in Appendix A.

Reclamation

APPENDIX D

TABLE OF CONTENTS
FOR
RECLAMATION

Page

Rules and Regulations of the Colorado Land Reclamation Board-------- II-1-25

RULES AND REGULATIONS
OF THE
LAND RECLAMATION BOARD

I. SCOPE AND PURPOSE

A. Scope and Purpose.

1. The purpose of these rules and regulations (hereinafter referred to as "rules") is to provide, during the mining process and after mining operations have been completed, for the reclamation of land subjected to surface disturbance by open mining and thereby conserve natural resources, aid in the protection of wildlife and aquatic resources, and establish recreational, home, and industrial sites, to protect and perpetuate the taxable value of property, and to protect and promote the health, safety, and general welfare of the people of this state.

2. These rules shall govern operations for the extraction of coal, sand, gravel, quarry aggregate, and limestone for construction purposes under mining permits issued pursuant to the Colorado Open Mining Land Reclamation Act of 1973, CRS 1973, 34-32-101, et seq. (hereinafter referred to as the "Act").

3. These rules shall govern the reclamation of all open mining operations on all lands within the State of Colorado.

4. All operators engaging in open mining shall comply with all applicable state and local laws, codes, rules and regulations.

B. Definitions.

1. Acid and toxic producing deposits - natural or reworked earth materials having chemical and physical characteristics that, under mining or postmining conditions of drainage, exposure, or other processes, may produce materials which contain detrimental chemical constituents such as acids, bases, or metallic compounds.

2. Adjacent surface owners - all owners of surface land adjoining the affected land.

3. Adjacent deep mining - any underground mine, active, inactive, or abandoned, within two hundred feet of all boundaries of the area of the affected land.

4. Affected land - the area of land from which any amount of overburden has been removed, or upon which any amount of overburden has been deposited, or both. This term also includes the disturbed surface of an area where a mining operation is being or will be conducted, including but not limited to: on-site private

ways, roads, and railroad lines; land excavations; development drill sites or workings; refuse banks or spoil piles; evaporation or settling ponds; work, parking, storage or waste discharge areas; areas in which structures, facilities, equipment, machines, tools, or other materials or property which result from or are used in such operations, are situated.

5. Board - the Land Reclamation Board established by section 34-32-105, CRS 1973.

6. Coal - all ranks of coal found in Colorado.

7. Department - the Department of Natural Resources or such department, commission, or agency as may lawfully succeed to the powers and duties of such department.

8. Executive Director - the Executive Director of the Department of Natural Resources, or such officer as may lawfully succeed to the powers and duties of such Executive Director.

9. Open Mining - the mining of natural mineral deposits of limestone used for construction purposes, coal, sand, gravel and quarry aggregate by removing any amount of overburden lying above such deposits and mining directly from the deposits thereby exposed. The term includes, but is not limited to, such practices as open cut mining, open pit mining, strip mining, quarrying and dredging.

10. Operator - Any person, firm, or corporation engaged in or controlling an open mining operation.

11. Overburden - all of the earth and other materials which lie above natural mineral deposits of limestone used for construction purposes, coal, sand, gravel and quarry aggregate. The term also means such earth and other materials disturbed from their natural state in the process of open mining.

12. Person - individual, corporation, government or governmental subdivision or agency, business trust, estate, trust, partnership, association or any other legal entity. Section 2-4-401 (8), CRS 1973.

13. Refuse - all waste material directly connected with the cleaning and preparation of substances mined by open mining.

14. Topsoil - the layer at the surface of the earth which has been so modified and acted upon by physical, chemical, and biological agents that it will support rooted plants necessary to achieve reclamation goals.

15. Vegetation character - the general aspect, density, form or appearance of the vegetation. The term shall include, but not be limited to, such expressions as grasslands, forest, desert,

shrubland, tundra, marsh or bog. These terms may be further qualified by the uses of modifiers such as upland, bottomland, ridge, hollow, or slope.

16. Vegetation density - an expression used as an equivalent to qualitatively estimated cover. It shall include and be limited to the following classes:

Dense = cover of 75% to 100%.
Moderate = cover of 50% to 75%.
Sparse = cover of 25% to 50%.
Scattered = cover of less than 25% but with the living plants still forming a dominant part of the landscape.
Rare = cover of less than 25% but with the living plants, during the growing season, not readily evident in the landscape.

Percent of cover means the proportion of the total ground area occupied by the perpendicular projection on to it of the aerial and living parts of the individuals of the species under consideration.

17. Vegetation type - a designation for a more or less natural grouping of plant species, named according to at least the two species that are visually dominant in that grouping.

II. PROCEDURES OF THE LAND RECLAMATION BOARD

A. General Procedures of the Board.

1. The State Administrative Procedure Code, article 4 of title 24, CRS 1973 (hereinafter referred to as the "A.P.C."), is applicable to all proceedings of the Board held under these rules except where the Board has adopted more comprehensive administrative procedures.

2. Three members of the Board shall constitute a quorum for the transaction of business. Action taken by the majority of the Board present shall be sufficient to bind the Board on all matters except changes of these rules. A majority of all of the members of the Board is required for the Board to change these rules.

3. The Board shall maintain an annual mailing list of persons who 1) request receipt of notice of meetings and proceedings of the Board; and 2) prepay the cost of reproduction, handling, and mailing of these notices. The Board shall determine so far as possible the annual cost of mailing these notices.

4. At least once a month the Board holds meetings to consider applications for permits, establishment and release of bonds,

amendments of permits and bonds, or general business. Any interested person may appear at these meetings and speak on the issues being considered. The Board shall establish a day each month when it shall hold regular monthly meetings unless circumstances require the day be changed. Not less than twenty (20) days notice shall be given when the day on which the regular monthly meeting has to be changed.

5. Meetings of the Board are held whenever necessary to consider revocation of permits, forfeiture of bonds, violations of the Act, adoption or changes in these rules, and setting of dates for the holding of a hearing, whenever the Board determines that circumstances so warrant. Public notice of meetings and hearings shall be given as required by the Act, these rules or the A.P.C. and all such meetings and hearings are open to the public.

6. In addition to meetings of the Board, any interested person may request a hearing concerning revocation of permits, forfeiture of bonds, violations of the Act, or adoption or changes in these rules. At such time, the Board may determine, by majority vote of the members present, whether to hold a hearing.

7. During the consideration of an application for a permit, should the Board decide a hearing is necessary to fulfill the requirements of the A.P.C., the Board may, at its option, hold the hearing in the community in which the property to be affected by the application is located. The appropriate public notice of the meeting will be given.

B. Procedures Governing Public Notice to be Given by the Operator.

1. After the Board has set a date for consideration of an application or release of a permit bond, the applicant or operator shall be responsible for giving public notice of his submitted application at least twenty (20) days before this Board meeting. The applicant or the operator shall submit appropriate proof of the notice to the Board. Acceptable forms of public notice shall require:

   a. Publication of a legal notice in one local newspaper and one newspaper of general circulation; and
   b. Submission of a press release to one local newspaper and one newspaper of general circulation; and
   c. Posting on the land proposed to be covered by the permit or to be released from the bond on a form supplied by the Board, at a reasonable cost, in at least four conspicuous places on the perimeter of the subject land such as roads, gates, or other such structures; and
   d. Notice to the applicable local governing board and planning commissions.

2. Each of the notices required above shall include:

   a. Legal description and general description of the location of the land proposed to be covered by the permit or to be released from the bond. Street addresses should be given when appropriate; and

b. Size of the property in acres; and
c. Purpose of the meeting; and
d. Name of the applicant; and
e. Date, time, and place of the board meeting; and
f. Name, address and phone number of the Board; and
g. A statement to the effect that a copy of the permit or bond release application is available in the office of the local governing board or body and the office of the Land Reclamation Board.

3. For Board meetings to consider requests for amendments, extensions, and/or renewals of permits, the Board may require the public notice requirements of subsections II-B-1 and 2 of these rules, or an appropriate modification thereof.

C. Procedures Governing the Processing of Applications for Open Mining and Reclamation Permits.

1. All open mining operations which fall within the scope of the Act must acquire a permit from the Board prior to commencing any mining operations or overburden removal.

2. The Board is the sole administrative agency with the power and authority to administer the provisions of the Act.

3. The Board shall have a minimum of sixty (60) days and a maximum of one hundred twenty (120) days to process an application for a permit. The sixty (60) days commence from the date of receipt of the completed application. In the event of serious unforeseen circumstances or snow cover on the subject property that prevents a necessary on-site inspection, the Board may reasonably extend the maximum time.

4. No application shall be considered for approval by the Board until it is complete in all respects. An application is complete when all state and local statutory and regulatory requirements pertinent to the purposes of the Act have been fulfilled, and the Board has all necessary forms, documents, certifications, reports and affidavits.

5. The Board shall have a minimum of forty-five (45) days and a maximum of one hundred twenty (120) days to process renewals or significant amendments of permit applications. In the event of serious unforeseen circumstances or snow cover on the subject property that prevents a necessary on-site inspection, the Board may reasonably extend the maximum time. The procedures for consideration of amendments and renewals to existing permits shall correspond to the same procedures required for initial applications for permits. The renewal and amendment applications shall be accompanied by the appropriate materials required by section 34-32-110 (6), CRS 1973.

6. If the property is sold, leased or transferred in any manner, the new owner, lessee or person having control must file a request to succeed the operator with the Board, and shall be bound to the uncompleted period of the reclamation plan, and shall submit and keep in force a valid performance bond until such time as the Board, by formal action, releases the successor operator from such bond liability.

7. Whenever the Board or the reclamation staff of the Department of Natural Resources believes that review of the application by other state agencies is necessary, permit applications shall be submitted by the Board or the staff to those agencies for comment and review. Agencies that may review such application shall include, but not be limited to, the Divisions of Water Quality, Parks and Recreation, Wildlife, and Mines; the Department of Agriculture; the State Soil Conservation Board, the Colorado Geological Survey, the State Forester, the State Engineer, and state institutions of higher education.

D. Procedures Governing Permit Approval or Denial.

1. Approval.

   a. Upon submission of an application for a permit to the Board, the Board must find in writing that the mining and reclamation plans are reasonable and in accordance with the purposes and requirements of the Act as set forth in the reclamation performance standards, section 34-32-111, CRS 1973, to issue a permit; otherwise the application will be denied.

2. Denial.

   a. The Board shall submit in writing to the applicant its findings and reasons for denying a permit.
   b. An applicant refused a permit may, for sufficient cause, reapply and request the Board's reconsideration.

III. APPLICATIONS

A. Written Applications. The written application for an open mining permit shall be submitted to the Board in the form prescribed by the Board.

B. Complete Application. All information submitted to the Board with the application for a permit must be accurate and complete. All tests, analyses, surveys, maps and reclamation plans submitted pursuant to the Act or the rules promulgated thereunder shall be done or certified by qualified persons unless otherwise specified in these rules. The method and/or procedures used in tests, analyses or surveys shall be described.

C. Number of Copies Required. A minimum of five (5) copies of all information required in the application, including maps, analyses, exhibits and other information shall be provided to the Board. Additional copies may be requested by the Board. One of these copies shall be forwarded to the office of the governing board of the local governmental unit in which the land is located.

D. Fees. The application shall be accompanied by a basic fee of fifty dollars ($50) plus fifteen dollars ($15) for each acre or fraction thereof of the affected land.

E. Applications for Ten (10) Acres or Less.

1. Proposed operations whose total surface disturbance related to the mining operation will affect ten (10) acres or less of land may submit an application modified in such ways as set forth in the following subsections: F-11-b, 12-b and H-2 of section III.

2. Surface disturbance shall mean the area of land from which any amount of overburden has been removed, or upon which any amount of overburden has been deposited, or both, and shall include, but not be limited to: on-site private ways, roads, and railroad lines; land excavations; development drill sites or workings; refuse banks or spoil piles; evaporation or settling ponds; work, storage or waste discharge areas; areas in which structures, facilities, equipment, machines, tools, or other materials or property which result from or are used in such operations, are situated.

3. Subsequent enlargement of affected land by the same or affiliated operator shall result in the operation becoming subject to all the requirements for an operation in excess of ten (10) acres.

4. The staff shall make an inspection of the proposed permit area and report to the Board. If, in the opinion of the Board, the proposed open mining operation would have significant long term adverse effects on the proposed permit area, the Board shall require the full detailed application form as if the operation were in excess of ten (10) acres.

5. The reclamation performance standards are the same for all open mining operations regardless of the size of the operation.

F. Required Information.

1. The legal description and general description of the location of the land to be affected by the open mining operations. Street addresses shall be given when appropriate. The term "open mining operations" shall include all phases of all activities employed in the mining and reclamation processes. It shall include all affected lands as defined in subsection I-B-4.

2. A brief legal description and indication of adjacent lands to be disturbed by future open mining operations beyond the term of the permit.

3. The owner or owners of the surface of the area of land to be affected.
4. The owner or owners of the substance to be mined.
5. The source of the applicant's legal right to enter and open mine on the land affected by the permit.
6. The address and phone number of the general office and the local address or addresses and phone number of the applicant.
7. When applicable, the name, address, and phone number of the corporation's registered agent.
8. A list of any other permits held or previously held by the applicant or any affiliated person under this Act and an identification of such permits.
9. A detailed description of the mining plan to be employed.
10. The size of the area or areas to be worked at any one time.
11. Wildlife Occurrence.

    a. All operations over ten (10) acres. A description of wildlife (terrestrial and aquatic) occurrence on or adjacent to the site of the application area including a narrative that describes:
        (1) Wildlife occurrence; and
        (2) Seasonal occurrence of the predominant species; and
        (3) The presence on and adjacent to the site of species listed on the Colorado Division of Wildlife list of threatened and endangered species; and
        (4) The impact of the operation on the wildlife with regard to displacement of wildlife and extent of replacement of suitable habitat for wildlife that would inhabit the area after the completion of the operation; and
        (5) A written statement from the Colorado Division of Wildlife discussing the impact of the proposed operation upon wildlife or their habitat; and
        (6) The statement required in (5) above shall also include any recommendations the Division of Wildlife may wish to make regarding the proposed operation.

    b. All operations of ten (10) acres or less. The operator shall prepare a brief report with the assistance of the local representative of the Colorado Division of Wildlife setting forth:
        (1) Wildlife in the area; and
        (2) The wildlife habitat; and
        (3) Any endangered or threatened species which occur in the area or are occasional visitors; and
        (4) A written statement from the Colorado Division of Wildlife discussing the impact of the proposed operation upon wildlife or their habitat; and

(5) The statement required in (4) above shall also include any recommendations the Division of Wildlife may wish to make regarding the proposed operation.

12. Water Resources.

a. All operations over ten (10) acres. A narrative, supplemented with diagrams and tests of the water resources on and in the vicinity of the application area, shall be submitted. Such narrative shall include:
(1) Both surface and underground resources; and
(2) A description of the impact of the operation on the quality and quantity of water resources; and
(3) Demonstration of water right ownership to supply any necessary water requirements for operations or impoundments, whether temporary or permanent; and
(4) All necessary permits and certificates from the offices of the Colorado Water Quality Control Division and the Colorado State Engineer; and
(5) If no permits or certificates are necessary, the operator shall submit a written statement from the above two agencies which states that none are necessary; and
(6) The State Engineer and the Water Quality Control Division may submit a written statement making any recommendations they may have concerning the operation.

b. All operations of ten (10) acres or less.
(1) A description of the surface and underground water resources; and
(2) A description of the impact of the proposed operation on the quality and quantity of these resources; and
(3) All necessary permits and certificates from the offices of the Colorado Water Quality Control Division and the Colorado State Engineer; and
(4) If no permits or certificates are necessary, the operator shall submit a written statement from the above two agencies which states that none are necessary; and
(5) The State Engineer and the Water Quality Control Division may submit a written statement making any recommendations they may have concerning the operation.

13. The operator's estimated costs of each of the following segments of the reclamation process, including where applicable backfilling, grading, highwall reduction, topsoiling (if done), planting, revegetation management and protection prior to vegetation establishment, and administrative costs. At the request of the operator information pertaining to the detailed breakdown of the cost of reclamation may be held confidential upon a showing of good cause.

14. A timetable stating the periods of time which will be required for the various stages of the mining and reclamation operations.

G. Specifications for All Maps. Several base maps may be required to efficiently and legibly portray the applicable required information as set forth in subsection H. of this section. All maps shall indicate the name of the applicant, the name of the person who prepared the map, and the date the map was prepared. All maps, except the index map, shall:

1. Have a scale of not less than one hundred (100) feet to the inch and not more than six hundred sixty (660) feet to the inch, and

2. Show the quarter-section, section, township, range, the proper meridian, and county lines which fall within the scope of the map; and

3. Outline the area of land to be affected as defined in subsection I-B-4 of these rules.

H. Information to be Contained on Maps.

1. Maps for operations over ten (10) acres.

   a. Identification of adjacent deep mining and adjacent surface owners; and
   b. Name and location of all creeks, roads, buildings, oil and gas wells and lines, and power and communication lines on the area of affected land and within two hundred feet of all boundaries of such area; and
   c. Total area to be involved in the operation including the area to be mined and the area of land affected; and
   d. Topography of the area with contour lines of sufficient detail to portray the direction and rate of slope of the land covered in the application; and
   e. General type, thickness, and distribution of soil over the area covered by the permit application indicating the soil series and the texture, pH, and conductivity of the upper six inches of the soil; and
   f. Type, character, and density of present vegetation occurring in the area covered by the permit application; and
   g. Depth and thickness of the coal, sand, gravel, quarry aggregate, or limestone used for construction purposes, to be mined and the thickness and type of the overburden to be removed; and
   h. A typical cross-section should be constructed indicating the topography and any aquifers occurring in the area that would be affected by the mining. Cross-sections should indicate both original and post mining conditions; and
   i. Aerial photographs, when available, of reasonable scale and of a date which reasonably portrays the current condition of the area to be covered by the permit application. The area to be covered by the permit shall be outlined on the aerial photograph; and

j. An index map showing the regional location and all roads and other access to the area. A standard U.S.G.S. topographic quadrangle or equivalent alternative would be acceptable for the index map.

2. Maps for operations of ten (10) acres or less.

   a. Indentification of adjacent deep mining and adjacent surface owners; and
   b. Name and location of all creeks, roads, buildings, oil and gas wells and lines, and power and communication lines on the area of affected land and within two hundred feet of all boundaries of such area; and
   c. Total area to be involved in the operation including the area to be mined and the area of land affected; and
   d. Topography of the area with contour lines of sufficient detail to portray the direction and rate of slope of the land covered in the application; and
   e. The operator shall prepare a map or brief report, with the assistance of the local soil conservation district, setting forth the soil series and the texture, pH, and conductivity of the upper six inches of the soil; and
   f. The operator shall prepare a map or brief report, with the assistance of the local soil conservation district, describing the type, character, and density of present vegetation occurring in the area covered by the permit application; and
   g. Depth and thickness of the coal, sand, gravel, quarry aggregate, or limestone used for construction purposes, to be mined and the thickness and type of the overburden to be removed; and
   h. Aerial photographs, when available, of reasonable scale and of a date which reasonably portrays the current condition of the area to be covered by the permit application. The area to be covered by the permit shall be outlined on the aerial photograph; and
   i. An index map showing the regional location and all roads and other access to the area. A standard U.S.G.S. topographic quadrangle or equivalent alternative would be acceptable for the index map.

I. Reclamation Plan and Map. Accompanying the permit application, every operator shall submit a reclamation plan and map.

1. The reclamation plan shall be based upon provisions for, or satisfactory explanations of, all general requirements for the type of reclamation proposed to be implemented by the operator. The plan shall be based upon the advice of technically trained personnel experienced in that type of reclamation on open mined lands and upon scientific knowledge from research in reclaiming and utilizing open mined lands. Reclamation shall be required on all the affected land.

2. The reclamation plan shall include:

    a. A narrative describing 1) which of the approved uses the operator proposes to achieve in the reclamation of the affected land, 2) why each use was chosen, and 3) the amount of acreage accorded to each; and
    b. A narrative describing how the reclamation plan will be implemented to meet the performance standards set forth in these rules and evidence to show that the reclamation plan will be achieved; and
    c. A proposed timetable indicating when and how the reclamation plan shall be implemented; and
    d. A narrative describing how the reclamation plan shall rehabilitate the surface disturbances caused by the open mining operation. The narrative shall include but not be limited to the following factors: natural vegetation, wildlife, water, air and soil resources.

3. The map accompanying the reclamation plan shall include all of the land to be affected by all phases of the total scope of the open mining operations. It shall indicate:

    a. The expected physical appearance of the area to be mined and the area of land affected, correlated to the timetable; and
    b. Portrayal of the proposed final land use for each portion of the affected lands.

4. Prior to approving any new reclamation plan or approving a significant change in any existing reclamation plan, the Board shall confer with the local board of county commissioners and the board of supervisors of the Soil Conservation District if the open mining operation is within the boundaries of a Soil Conservation District.

IV. ANNUAL RECLAMATION REPORTS

A. To enable the Board to ascertain whether the approved reclamation plan is progressing satisfactorily and according to the timetable approved in the original application, the operator shall submit to the Board three copies of an annual reclamation report that sets out in detail all measures taken to reclaim the affected area and the progress of the mining operation, during the twelve month period beginning on October 1 and ending on September 30. This report is to be submitted to the Board before March 1 of the following year.

B. Such report shall include:

1. A statement of the operator's name, address and permit number; and

2. The number of acres of affected land resulting from operations during the preceding year; and

3. The number of acres for which grading was initiated and/or completed during the preceding year; and

4. The number of acres for which revegetation was initiated and/or completed during the previous year; and

5. The species of vegetation planted, rates and dates of planting, and where each was utilized in the planting plan; and

6. An appraisal of the success of reclamation efforts; and

7. In the event of any failure of revegetation efforts initiated in the past year or any previous year, a short narrative as to the suspected or determined causes of such failure; and

8. A statement of the type and quantity of any fertilizers, organic material or soil conditioners introduced, and a description of any irrigation utilized on the affected area prior to or during revegetation; and

9. Any information concerning unique problems or solutions to such problems of reclamation technology that might have been encountered in the process of reclaiming the affected land which might be of assistance to the Board in the completion of their duties in administering this Act; and

10. An appraisal of success made in meeting the approved timetable for completion of reclamation of the affected lands.

C. The above mentioned report shall be accompanied by a map or suitable overlay of maps submitted with the original application. Such maps shall show:

1. The outline of the affected area; and

2. An outline of all areas regraded and topsoiled during the previous year; and

3. An outline of the areas seeded during the previous year, showing the dates of seeding; and

4. An outline of the area revegetated during the previous year; and

5. An outline of any and all areas where reclamation has been completed during the previous year; and

6. Where final grading and contouring have been completed, during the previous year, an outline of the final grading plan showing the final elevation by contours; and

7. An outline of that portion of the affected area upon which mining was conducted during the previous year; and

8. The map shall show progress made to date and progress required to be made under the timetable approved in the permit application.

V. RECLAMATION PERFORMANCE STANDARDS

A. General.

These reclamation performance standards shall apply to open mining of coal, sand, gravel, quarry aggregate and limestone used for construction purposes. All operations performed under permits issued by the Board shall be carried out in a manner consistent with standards set forth in the Act and in the rules promulgated thereunder.

B. Grading.

1. All final grading of the area of land affected shall produce a gently undulating topography or other such topography as is consistent with the proposed land use of the area as stated in the plan, provided, however, such grading shall create a topography that is reasonable in view of the public interest in physically attractive surroundings.

2. Grading shall be done in a manner as to control erosion and siltation of the affected area, surrounding property, and water courses. After consultation with the operator, the Board may require terracing to conserve moisture and control water erosion on all graded slopes during the process of current grading. Terraces if used may be installed in such a manner as not to prohibit vehicular access or revegetation procedures. Terraces shall be installed at varying intervals as determined by climatic conditions, spoil, topsoil or topsoil substitute composition and texture, slope, steepness, and slope length. Suggested terrace installation intervals shall be submitted in the reclamation plan.

3. Mining and grading shall not affect the drainage or stream flow in a manner that would impair or be detrimental to existing water rights and to existing water quality.

4. Backfilling and grading of the disturbed area shall be completed as soon as feasible after the mining process. The operator shall establish reasonable timetables for backfilling and grading consistent with good mining procedures.

5. All debris, acid-forming materials, saline materials, toxic materials, materials constituting a fire hazard or materials not conducive to vegetation growth and establishment shall be disposed of in such a manner as to prevent contamination of ground and surface waters, to prevent sustained combustion, and to prevent inhibition of plant growth and establishment. Identification of such materials shall be the responsibility of the operator. This section shall be interpreted in conformity with the rules and regulations of the Water Quality Control Commission and State Engineer.

6. The operator shall not use excavated areas for the deposition of foreign materials such as trash, industrial wastes, fly ash and

other materials not naturally occurring or commonly found in the earth in the mined area, unless tests and analyses on the materials and the method of disposal have demonstrated, prior to permit approval or by permit amendment, that such deposition would not have any significant adverse or detrimental effect on ground water, surface water, soil stability, revegetation or other reclamation requirements, or pose a threat of combustion.

7. The operator shall place spoil materials, stockpiles, and other materials resulting from any aspect of mining or reclamation operations in such a location and manner as to protect all on- and off-site areas and persons working on or off the site from slides or damage, including air or water pollution.

8. In all cases where a lake, pond or other body of still water is produced as a portion of the reclamation plan all slopes, unless otherwise approved by the Board, shall be no steeper than a ratio of two horizontal to one vertical, except from five feet above the expected water line to ten feet below the expected water line where slopes shall be no steeper than three horizontal to one vertical. If a swimming area is proposed as a portion of the reclamation plan, the slope, unless otherwise approved by the Board, shall be no steeper than five horizontal to one vertical throughout the area proposed for such swimming use, and a slope no steeper than three horizontal to one vertical elsewhere in the same body of water.

9. In the case of sand and gravel operations, the mining and reclamation plan shall, wherever possible, segment the life of the operation into five year or shorter intervals. Extraction in each segment shall be completed and reclamation begun within five years after the initial permit is issued.

C. Topsoiling.

1. All available topsoil shall be removed from areas of excavation within the affected area before removal of materials underlying the topsoil. Topsoil removal shall precede each step of the mining process. The operator shall indicate in the reclamation plan the equipment and procedures to be used in topsoil salvage and redistribution.

2. Topsoil stockpiles shall be located in areas where they will not be disturbed by on-going mining operations, provided, however, such stockpile areas must be included in the affected areas and subject to all reclamation requirements.

3. The Board will require topsoil be replaced on the backfilled and graded area in a short enough time to prevent deterioration of the topsoil. In the event backfilling and grading is not possible within this time, the Board may require immediate planting of an

annual and/or perennial crop on topsoil stockpiles for the purpose of stabilization. The Board may require that fertilizer or other soil amendments may be added in accordance with the approved reclamation plan or as indicated by tests.

4. All unnecessary compaction and contamination of the topsoil stockpiles shall be eliminated. Once stockpiled, the topsoil shall not be rehandled until replacement on the regraded, disturbed area, unless otherwise approved by the Board.

5. Spoil surfaces shall be left roughened in final contour grading to eliminate slippage zones that may develop between the deposited topsoil and heavy textured spoil surfaces. The operator shall take all measures necessary to assure the stability of topsoil on graded slopes.

6. If existent topsoil is of insufficient quantity or of poor quality for sustaining vegetation, and if other materials can be shown to be more suitable for vegetation requirements, then the operator shall remove, segregate, and preserve in a like manner such other materials which are best able to support vegetation.

D. Planting and Revegetation.

1. The operator shall establish on the regraded areas and all other lands affected by the open mining operation, a diverse, effective, and permanent vegetative cover native to the area of land to be affected and capable of self-regeneration and plant succession without dependence on irrigation, soil amendments or fertilizer, at least equal in extent of cover to the natural vegetation of the area prior to any mining. As a method of preparing the land for establishment of native species, introduced species may be utilized on a temporary basis.

2. On a permanent basis, the operator may use introduced species in lieu of native species only for certain specific post-mining land uses approved by the Board or when native seeds or plant materials are not available. These post-mining land uses are limited to long-range, intensive agriculture (including grazing), recreational, industrial, or residential developments. In the case of residential, industrial, and recreational developments, compatibility with land use plans and demonstrated evidence of intent to actually develop these post-mining land uses are required.

3. In providing for the greatest probability of success in seed germination, plant survival, and vegetation establishment and development, the operator shall consider soil, climate, and relevant ecological and physiological factors.

4. The operator shall implement the reclamation plan approved by the Board so that the species of grasses, legumes, forbs, shrubs

and trees planted, the pattern and density of seeding and/or planting, and the time of seeding or planting conform to the reclamation plan approved by the Board in granting the mining permit. In all cases, whether adapted or non-adapted seed is used, the source of the seed or seedlings shall be reported to the Board.

5. An operator shall use any means necessary to insure the establishment of a diverse and permanent vegetative cover, including, but not limited to, mechanical soil conditioning such as discing and ripping, mulching, soil amendments and fertilizers, protective measures, hydroseeding or hydromulching and irrigation, provided, however, the methods employed above shall be brought to the attention of the Board through the annual reports.

6. Not more than sixty (60) days prior to the application of any fertilizer to regraded, revegetated or reclaimed land, the soil shall be examined by appropriate soil tests to determine actual fertilization needs of the land to be treated. The results of all tests shall be reported to the Board not less than ten (10) days prior to the planned application. For good cause shown the Board may extend the time period in which to conduct said test.

7. As a temporary measure, the operator may use an immediate application of mulch to affected lands that do not have any other permanent or temporary cover established when the grade or length of any slope presents a likelihood of deposition of sediment into any surface waters. Permanent elimination of such sedimentation threat must then be carried out at the earliest opportunity.

8. The operator shall employ methods of weed control whenever invasion of a reclaimed area by annual, biennial, or perennial weed species seriously threatens the continued development of the desired vegetation. Weed control methods shall also be used whenever the inhabitation of the reclaimed area by weeds threatens further spread of serious weed pests to nearby areas where the presence of such weeds would be clearly undesirable.

9. The operator may select either or both of two methods of weed control:

   a. Mechanical control, and
   b. Chemical control.

   The method of control shall be reported to the Board prior to implementation. The selection of weed control measures shall consider:

   a. The effect of the control program on the existing or desired vegetation, and on the final land use; and

b. The degree of invasion of weeds into the affected area to be considered for control as indicated by a comparison of cover and density of weeds to desired species; and
c. The species of weeds invading the affected area; and
d. The impact of the proposed weed control program on other resources that may actually or potentially be harmed on and off the affected area.

E. Fencing.

1. Appropriate fencing, as approved by the Board, shall be required in certain instances to protect revegetation efforts, insure public safety, protect wildlife, regulate livestock, and control public access and vehicular traffic.

2. All fences shall be constructed in such a manner as to provide the least hazard and greatest mobility to wildlife.

3. In urban areas, the operator shall fence the affected area with a six (6) foot high chain link fence topped with three (3) strands of barbed wire canted outwards, unless otherwise approved by the Board.

F. Water Resources.

1. All operators shall comply with the following requirements and with all applicable water quality standards established under federal, state or local laws and the rules adopted pursuant thereto, as required by the plans approved by the Board.

2. Violation of applicable federal, state and local laws in the areas of water quality and water resources may constitute grounds for revocation or suspension of a permit issued under this Act and these rules promulgated thereunder.

3. Permanent water impoundments may be created only when it is adequately demonstrated to the Board that:

   a. The intended impoundment has a subsequent beneficial use and is consistent with the overall land use plan; and
   b. The size of the impoundment is adequate for its intended use; and
   c. The impoundment dam or other structures of similar function, if such a structure is to be constructed, will be so designed as to achieve necessary stability with an adequate margin of safety; and
   d. The quality of impounded water will be suitable on a permanent basis for its intended use, and that discharges from the impoundment will not degrade the water quality in the receiving stream. Evidence of a point source permit must be presented to the Board; and

e. The level of water will be reasonably stable for its intended use; and
f. Final grading of access and below water slopes will provide adequate safety for proposed water users throughout the duration of the life of the impoundment and/or the life of its planned use; and
g. Such water impoundments will not result in the diminution of the quality and quantity of water utilized by adjacent or surrounding land owners for agricultural, industrial, recreational or domestic uses; and
h. Rights for adequate water to fulfill his requirements are owned, leased or under option by the operator or the land owner.

4. Where applicable, the operation shall conform to all rules and regulations of the Colorado Water Quality Control Commission and the State Engineer, and minimize the disturbances to the prevailing hydrologic balance at the mine site and in associated offsite areas, and to the quality and quantity of water in surface and ground water systems both during and after open mining operations and during reclamation by:

   a. Avoiding acid or other toxic mine drainage by such measures as, but not limited to, the prevention or removal of water from contact with toxic producing deposits, the treatment of drainage to reduce toxic contents which adversely affects downstream water upon being released to water courses; and
   b. Conducting open mining operations so as to prevent additional contributions of suspended solids to stream flow or runoff outside the permit area above natural levels under seasonal flow conditions as measured prior to any mining, and avoiding, where at all feasible, channel deepening and/or widening in operations requiring the discharge of water; and
   c. If the water supply of an owner of interest in real property who obtains all or part of his supply of water for domestic, agricultural, industrial or other legitimate use from an underground or surface source has been affected by contamination, diminution or interruption proximately resulting from mining, the operator shall be responsible for correcting the problem; and
   d. Where applicable, restoring recharge capacity of the mined area to approximate premining condition; and
   e. Such other actions as the Board may prescribe.

G. Wildlife.

1. Whenever the chosen land use allows for any degree of protection and/or augmentation of wildlife habitat, the operator shall consult with the Division of Wildlife regarding the reclamation plan. The proposed reclamation plan shall provide for protection of existing wildlife habitat and/or the improvement of additional suitable wildlife habitat that fulfills the subsequent beneficial use of the land.

2. All aspects of the mining plan shall take into account the safety and protection of wildlife on the mine site, at processing sites, and along all access roads to the mine site.

3. Habitat management and creation shall be directed toward encouraging the maximum practicable diversity of both game and non-game species, and the encouragement of a maximally integrated ecosystem capable of withstanding all reasonably expectable climatic extremes for the reclaimed land.

VI. ENFORCEMENT

A. Inspections and Monitoring.

1. The Board, the Reclamation Section of the Department, the Division of Mines, or their authorized representative may enter upon affected lands of the operator at all reasonable times for the purpose of inspection to determine whether there has been compliance with the provisions of the Act and the rules promulgated thereunder.

2. All reclamation inspections shall include the filing of a report at the:

   a. Main offices of the Board; and
   b. Offices of the operator; and
   c. Mine office; and
   d. Office of the County Commissioners or county planning office, or the municipality where the open mining operations occur.

3. All violations shall be reported immediately, in writing, to the operator and to the Board.

4. Each operation holding a permit shall be inspected a sufficient number of times each year to insure the operator maintains conformity with the reclamation plan. The frequency of inspection shall be determined by the extent of the operation, the rate at which the mining proceeds into unmined lands, and the degree of possible environmental impact the operation might have.

5. The Board or their designees shall annually inspect seeded areas at the end of the growing season at the respective site to ascertain if the approved reclamation plan is being successfully implemented by determining species diversity, germination, seedling take, and regenerative and successional trends where such considerations are applicable. If the Board determines the seedings or plantings are unsuccessful in terms of good germination and/or seedling take, or the vegetation is not developing (regenerating and/or succeeding) as was expected, immediate investigative action shall be taken by the operator at the request of the Board to determine the cause so that alternatives can be

employed to establish the desired permanent vegetative cover at the very next seasonal opportunity. The investigative report shall be submitted along with the prescribed course of corrective action prior to the next growing season.

B. Bonds.

1. After a surface mining and reclamation plan has been approved but before a permit is issued, the applicant shall file with the Board, on a form supplied by the Board, a performance bond, effective for the life of the permit, payable to the Board, and conditioned upon faithful performance of all the requirements set forth in the permit.

2. The amount of the bond required shall depend upon the reclamation requirements stated in the approved reclamation plan and shall be determined by the Board. The amount of the bond shall be sufficient in the event of bond forfeiture so that the State can complete the reclamation plan as indicated in the permit. addition, the amount of the bond shall be sufficient to cover all administration costs which the Board may incur in fulfilling the requirements of that operation.

3. The bond shall be in force throughout the life of the project.

4. The bond shall be executed by the operator and a corporate surety licensed to do business in the state of Colorado.

5. In lieu of such bond, the operator may deposit cash and government securities with the Board in an amount equal to that of the required bond determined in paragraph 2 of this subsection.

6. Any bond required to be filed by the operator by the Act and these rules promulgated thereunder shall not be cancelled by the surety without giving at least sixty (60) days notice to the Board prior to the anniversary date of its intent to limit exposure to existing circumstances as of the next anniversary date.

7. If the surety company notifies the Board of its intent to cancel the bond in a timely fashion, the operator shall, within thirty (30) days after receipt of such notification, provide substitute surety covering the operations or post cash bond in lieu thereof to take effect upon the cancellation date of the previous surety.

8. If the license to do business in this state of any surety of a bond filed with the Board pursuant to the Act and these rules promulgated thereunder is suspended or revoked, the operator, within sixty (60) days of receipt thereof from the Board, shall substitute good and sufficient surety licensed to do business in this state. If the operator fails to make such substitution of surety, the Board has the right to suspend the permit of the operator to conduct operations on the land described in such permit until such substitution has been made.

9. The amount of the bond or deposit required and the terms of each acceptance of the applicant's bond may be adjusted by the Board from time to time as the cost to carry out the reclamation required in the permit change due to economic conditions, or as significant stages of the reclamation plan are achieved to the satisfaction of the Board as set forth in section VI-C herein.

C. Determination of Reclamation Completion and Success.

1. The Board shall have the responsibility of affirmatively finding, in writing, that reclamation has been completed and is successful.

2. A judgment as to reclamation success shall be based upon each of the following considerations:

   a. Completion of the operator's plan of reclamation as set forth in the permit; and
   b. Full compliance with all applicable rules promulgated pursuant to the Act; and
   c. Capability of the land to sustain the planned land use.

3. If the Board finds the reclamation is not complete or successful, then a reconsideration of the reclamation completion and success may be petitioned by the operator, but not less than six (6) months after the final finding has been made by the Board.

D. Release of Performance Bond.

1. The operator may file a request with the Board for the release of all or part of a performance bond or deposit for an open mining operation.

2. Within a reasonable time after receipt of the request, the Board shall conduct an inspection and evaluation of the reclamation work accomplished.

3. The Board may release in whole or in part said bond or deposit if the Board is satisfied that the reclamation covered by the bond or deposit or portion thereof has been completed and is successful as defined by the Act and by these rules promulgated thereunder. The Board may release part of said bond or deposit for a significant area upon which final grading and contouring have been completed. If any part of the yet uncompleted portions of the reclamation plan presents a hazard of any sort to any completed portion of the plan, then the bond shall not be released on these completed portions of the plan.

4. If, however, the Board releases part of a bond or deposit, it shall retain a sufficient amount of the bond or deposit to guarantee revegetation of the part of the reclamation plan for which bond has been released.

5. In the case of reclamation for agricultural and horticultural crop production, the area shall have demonstrated for three (3) years a capacity to produce suitable crop yields commensurate with similar crop yields in the area.

6. In the case of commercial, recreational, industrial or residential post-mining uses, the operator shall demonstrate to the satisfaction of the Board that such uses will take place within a reasonable time. In judging this matter, the Board may consider such factors as approvals of relevant public agencies, demonstration of private financial capability, planned development schedule, specific design for development, assurance of investment necessary for public facilities, and demonstrated compatibility with adjacent land uses. If the operator cannot so demonstrate to the satisfaction of the Board, he shall amend his reclamation plan to achieve the reclamation goals of these rules.

7. If the reclaimed land area is to be utilized for range purposes, the Board may require incorporation of a grazing program after vegetation establishment to gauge stand tolerance to grazing pressure.

8. In the case of permits for sand, gravel, and quarry aggregate operations, the operator shall complete his operations and begin reclamation within five (5) years after the initial permit is issued. All reclamation shall be completed within three (3) years after the date the operator adivses the Board that reclamation has begun.

9. For all other operations, land stabilization and reclamation shall be completed within three (3) years after the date the operator advises the Board that reclamation has commenced.

10. In the event the mine area is subjected to severe drought that prevents establishment of vegetation and for which there is meteorlogical and/or evidence of crop failures that supports the contention of drought limitation to reclamation success, the three (3) year term for completion of the reclamation shall be extended one year for each growing season during which drought conditions exist that prevent the establishment of vegetation.

E. Violations and Bond Forfeiture.

1. Whenever the Board determines that an operator has not complied with the provisions of the Act and these rules promulgated thereunder, the Board shall, by conference, conciliation, and persuasion, endeavor to remedy such violation.

2. In case of the failure of such conference, conciliation, and persuasion to remedy any alleged violation, the Board shall cause to have issued and served upon the operator alleged to be committing such violation a written notice which shall specify the

provision of the Act and these rules promulgated thereunder which such operator allegedly is violating, and a statement of the manner in and the extent to which said operator is alleged to be violating the Act and these rules promulgated thereunder, and shall require the operator so complained against to answer the charges of such formal complaint at a hearing before the Board at a time not less than thirty (30) days after the date of the notice.

3. The Board shall enter such order as it deems appropriate to effectuate the purposes of the Act and these rules promulgated thereunder and shall forthwith mail a copy thereof to the charged operator or the operator's attorney of record. If such order of the Board is not complied with in the required time, the Board may then commence proceedings under section 34-32-113, CRS 1973.

4. In the case of violation of an order of the Board as provided above, then the Board shall notify the operator in writing of the alleged violation of or noncompliance with such order and shall afford the operator the right to appear before the Board at a hearing to be held not less than thirty (30) days after the receipt of such notice by the operator.

5. After the conclusion of the hearings, the Board shall either:

   a. Withdraw the notice of violation; or
   b. Request the Attorney General to institute proceedings to have the bond of the operator forfeited as to the land involved; and/or
   c. Request the Attorney General to institute proceedings to have the operator enjoined from further violation of the Board's order.

6. Any person required to have a permit by the Act and these rules promulgated thereunder who engages in open mining without previously securing a permit is guilty of a misdemeanor for each day of operation without a permit.

7. In such event, the Board shall request the proper authorities to institute proceedings to:

   a. Prosecute for violation of the Act and these rules promulgated thereunder;
   b. Enjoin further operation without a permit.

F. Public Inspection of Records.

1. The right to inspect all information required to be submitted under the Act and these rules shall be governed by the provisions of the Colorado Public Records Law, part 2 of article 72 of title 24, CRS 1973.

2. Copies of the complete application for a permit including maps, surveys, exhibits, tests and analyses, shall be available for public inspection at the office of the Board, and at the office of the local governing board for the area in which the land to be affected is located. At the request of the operator, information pertaining to the quality and quantity of the minerals proposed to be extracted may be held confidential. Such proprietary information shall be submitted, as indicated by the Board's application form, so that it is easily separable from the remainder of the information required by the application.

3. Written findings by the Board concerning the granting or denial of a permit application shall be on file for public inspection in the same places as the application itself.

4. Reports of reclamation inspections of the mine, violations of the Act, these rules, or the permit to engage in open mining, and report on the resolution of any violations shall be on file at the same places as the original application permit, as enumerated in paragraph 1 of this subsection.

5. Applications for partial or full release of bonds shall be on file for public inspection in the places enumerated in paragraph 1 of this subsection.

6. The Board's written findings and determinations concerning partial or full bond release shall be on file for public inspection in the places enumerated in paragraph 1 of this subsection.

Geologic and Geographic Setting

APPENDIX D

TABLE OF CONTENTS
FOR
GEOLOGIC AND GEOGRAPHIC SETTING

Table	Title	Page
III-1	Geologic Formations of Northwestern Colorado---------------	III-1-12

Geologic and Geographic Setting

TABLE III-1

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)^1	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Quaternary	Qal	Alluvium, including low terrace deposits.			Silt, sand and gravel; some clay; moderately sorted and bedded		River and other stream valleys.			Sand and gravel. Placer gold locally.
	Qx	High terrace and morainal deposits, talus rockfalls, collurium.			Sand, gravel; angular and unsorted materials; some silt and clay.		High terrace remnants along some streams and elsewhere; Talus and rockfalls along steep hills or cliffs.			Sand and gravel. Placer gold locally.
Tertiary										
Pliocene	Tv	Volcanic flows, plugs; intrusive dikes, sills, stocks.	--	Flows: Sills:	Basalt	Landslide potential where underlain by soft strata on steep slopes.	White River Uplift and scattered occurrences north to Elkhead Mts. and to Wyoming.			
Miocene	Tbp	Browns Park Formation.	--	2,200	Typically sandy conglomerate or gravel overlain by white fine-to coarse- grained partly tuffaceous sandstone or sand.	Very susceptible to landsliding where overlain by hard layers; subject to earth flows on steep slopes.	From near Craig west to Green River between prongs of Uinta Mts.; Elkhead Mts.; southern Routt County.			Uranium in Maybell-Lay area.
Miocene or Oligocene	Tbe	Bishop Conglomerate.	--	0-100	Coarse gravel or conglomerate.		On very high-surfaces in Uinta Mts.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)[1]	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Late Triassic		Popo Agie Formation	Equivalent to part of Chinle Formation to south and west.	0-120	Pale red to purplish red sandy siltstone overlain by claystone.		Present only near Hahns Peak and Clark, north of Steamboat Springs.			
		Jelm Formation	Equivalent to part of Chinle Formation to south and west.	0-100	Sandstone, fine-grained, micaceous, grayish-red and reddish-brown and purple; massive bedded.	Makes rounded ledges.	Present only near Hahns Peak and Clark, north of Steamboat Springs.			
Early Triassic		Moenkopi Formation	Partly equivalent to State Bridge Formation.	480-800	Grayish-green and red siltstone, shale and fine-grained sandstone; partly gypsiferous; few thin beds of limestone.	Forms slopes. Similar to Dinwoody in engineering characteristics.	Uinta Mts. area. Conspicuous alteration in Skull Creek area.			In Skull Creek area high metal content locally: V, Cr, Cu, Ni, Co, Ag, La, B, Hg.
Early Triassic		Dinwoody Formation		0-300±	Shale, sandy shale, thin sandstone beds. Light gray.	Non-resistant. Underlies low areas and forms soft rounded outcrops; moderately high natural stability but bearing strength not high.	Only in northwest corner of Moffat Co. Supports little vegetation.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)^1	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Late Jurassic	Jm	Sundance Formation	(Equivalent to Curtis, Entrada and Carmel)	0-260	Gray very fine grained sandstone; greenish gray shale; glauconitic sandstone and siltstone.	Sandstone forms cliffs and ledges; shale forms slopes.	Present only in eastern part of area.			
Early Jurassic and Late Triassic		Glen Canyon Sandstone	Navajo Sandstone Nugget Sandstone	0-540	Sandstone, fine-to-medium-grained thick-bedded; high cross-beds; gray to red.	Prominent cliff-forming sandstone in Uinta Mts.; forms high bare dome-shaped buttes (Cadigan)	Uinta Mts.; Skull Creek area. Has some four-toed dinosaur tracks.			
Late Triassic	Trc	Chinle Formation	Poyo Agie Formation. Jelm Formation. Chugwater Formation.	127-565	Red-siltstone claystone, sandstone; limestone-pellet conglomerate and some limestone.	Poor outcrops but mostly well indurated and should stand well in steep cuts.	Uinta Mts. have best exposures. Reptile fossils.			
		Gartra Member of Chinle Formation	(Formerly Shinarump Conglomerate)	0-250 Abruptly variable.	Poorly sorted sandstone and conglomerate. Pale lavender to grayish pink. Massive to cross-bedded.	Blocky outcrops; contributes large boulders on steep slopes.				Small uranium deposits near Skull Creek
		Nugget Sandstone (Bell Springs Member)	Equivalent to part of Chinle Formation to south and west.	0-50	Reddish-brown very fine grained thin-bedded sandstone and reddish brown siltstone; purplish limestone concretionary beds.	Weathers to slabby or rounded ledges and slopes.	Present only near Hahns Peak and Clark, north of Steamboat Springs.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)[1]	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Late Jurassic	Jm	Morrison Formation	--	440-800 486 at Juniper Mtn.	Variegated soft bentonitic shales and mudstones; medium-to-coarse grained sandstones; chert, pebble conglomerate.	Mudstones are plastic when wet and thus unstable. Landslides observed.	Fossil dinosaur bones at Dinosaur National Monument.		Gas shows	
		Curtis	Upper Sundance of Wyoming; Stump Fm. of northern Utah.	0-260 45 at Juniper Mtn.	Sandstone, shale and thin-bedded limestone; gray to greenish gray. Glauconitic. Marine origin.	Varies because of variable lithology. Moderate to high slope stability and bearing strength.	Especially Uinta Mts. and Juniper Mt. Marine fossils common.			Copper-uranium vandium deposit near Skull Creek.
		Entrada	Sundance Fm. to northeast. Preuss sandstone to northwest.	22-360	Sandstone, fine-to-medium grained, buff-to light gray. Locally has siliceous cement. Some red or brown mudstone.	Generally forms cliffs or steep slopes. Relatively resistant and stable.	Juniper Mt. and Uinta Mts. especially. Generally has good porosity and thus excellent aquifer.			
		Carmel	Basal part of San Rafael Group in Utah.	0-125	Sandstone, silty; shale and siltstone; reddish brown; some gypsum. Marine origin.	Form slopes mostly; unstable at relatively low slope angles. Some landslides and slumps observed.	Only in Uinta Mts. Pinches out eastward. Some dinosaur tracks.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)1	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest: Coal (rank)	Deposits of Economic Interest: Oil( ) Gas( )	Deposits of Economic Interest: Other
Upper Cambrian	El	Lodore Formation	Sawatch Quartzite	0-400	Sandstone, white, topped, quartzite, partly arkosic, with some silty shale interbedded.	Forms nearly vertical cliffs.	In Uinta Mts. area, Cross Mts. and Juniper Mtn.			
Precambrian	PE	(Unnamed)	--	(Thousands)	Granitic and mafic intrusive rocks; gneiss, schist and other metamorphic rocks.	Mostly quite resistant to erosion, forms steep high mountain slopes.	Forms the high Park, Gore, and Sierra Madre Ranges along east east side of area.			Uranium minerals near Steamboat Springs.
		Uinta Mountain Group		24,000±	Mostly red to white, medium to coarse-grained, quartzitic, partly arkosic, massive to cross-bedded sandstones; some conglomerate.	Forms bold rugged outcrops and sheer cliffs. Resistant to erosion, great strength. Brittle, but stable foundations.	Eastern Uinta Mts.; Cross and Juniper Mts.			
		Red Creek Quartzite	--	20,000±	Metaquartzite, amphibolite, and mica schist.	Very hard but brittle, Great bearing strength stable except some mica schist zones.	Only in small part of northeastern Uinta Mts., where it forms all high peaks.			Barite, copper, and uranium occurrences

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)1	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest		
								Coal (Rank)	Oil( ) Gas( )	Other
Upper Devonian	MDE	Chaffee Group		0-225±	Dolomite and limestone, partly oolitic; cherty; some green shale, quartzite.	Lower part forms slope. Upper part forms cliffs and slopes and has solution cavities 0.3-1.5 feet in diameter.	White River Uplift and southern Routt Co. Possibly, 20-30 feet of dolomite at base of Madison at Cross and Juniper Mts.			
Lower Ordovician	MDE	Manitou Formation		0-155	Upper half thin-bedded siliceous dolomite; lower half interbedded flat-pebble conglomerate and limy shale.	Upper half forms steep cliff, lower half forms cliff or steep slope.	White River Uplift area and southeast Routt Co.			
Upper Cambrian	MDE	Dotsero Formation		0-106	Dolomite, brownish-gray, thin-bedded; flat-bedded limestone and dolomite-conglomerate; thin beds green-gray shale.	Forms steep slope between a cliff below and overlying slope and cliff.	White River Uplift area and southeast Routt Co.			
	Es	Sawatch Quartzite	Lodore Fm.	0-400±	Regularly bedded quartzite sandstone, sandstone and quartzite; some dolomite and shale.	Very resistant, forms steep cliffs.	Only in southern Routt Co. and White River Uplift area.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)[1]	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Pennsylvanian	Pm	Morgan Formation	Equivalent to most of Minturn Minturn Formation	0-1,280 1,019 at Juniper Mtn.	Limestone, sandstone and variegated shale beds; dolomitic and nodular limestone.	Generally quite resistant to erosion except for shale beds.	Well developed at Juniper Mtn., where Yampa River cuts through more than 1,000 feet. Quite fossiliferous.			
		Minturn Formation	Equivalent to Morgan Formation	0-1,000+	Lenticular beds of arkosic conglomerate, shale and quartzite with some beds of dolomite and limestone.	Relatively resistant to erosion,forms cliffs and steep slopes.	Southern Routt Co.			
		Eagle Valley Formation		(Uncertain)	Gypsum or anhydrite and interbedded gray shale, siltstone and thin limestones.	Subject to diapiric and dissolution.	Only along White River 20 to 30 miles east of Meeker			
Mississippian	Mm	Madison Limestone	Equivalent to Leadville Limestone. Other Fms. in Utah	0-600 270 at Juniper Mtn.	Limestone and dolomite light to dark	Porous and cavernous; has many calcite-filled cavities; cliff-forming	Juniper Mtn. Eastern Uinta Mts. and Cross Mt. Caverns in Green River canyons.			
	MDE	Leadville Limestone	Equivalent to Madison Limestone	0-200+	Mostly limestone. Lower half has dolomite and dark gray chert. Upper half oolitic limestone.	Forms light-gray cliffs capping steep slopes.	White River Uplift.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)[1]	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Triassic and Permian		State Bridge Formation	Partly equivalent to Moenkopi and Park City Formations.	0-500	Red and gray siltstone and shale; some sandstone.		Southern Routt Co.			
Permian		Park City Formation	Khsphoria Formation	50-290	Gray, yellow and red siltstone and shale; thin-bedded limestone and dolomite; sandstone; some phosphate, chert.	Limestone predominates in places and makes long resistant hill slopes.	Uinta Mts.			Phosphate rock, especially in Utah.
Permian and Pennsylvanian	Pw	Weber Sandstone	Equivalent to Maroon and upper part of Minturn Fm.	0-1,000±	Sandstone, fine-grained, cross-bedded, thick-bedded, gray to white and buff.	Form steep-walled canyons and rocky tree-covered slopes.	Uinta Mts., especially canyon of Yampa River.			Small uranium deposit near Skull Creek.
		Maroon Formation	Partly equivalent to Morgan and Weber Fms.	0-2,000±	Red, yellow and brown mudstone, sandstone, arkose, and conglomerate with some beds of gypsum and thin limestone.	Very susceptible to landslides, mudflows, slumps.	Southern Routt Co.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)1	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest: Coal (rank)	Deposits of Economic Interest: Oil( ) Gas( )	Deposits of Economic Interest: Other
	Kmv	Mesaverde Group, undivided		2,750 - (east) 2,500 - (Rangeley)	Thick beds of light brown sandstone and some thick key beds of white sandstone interbedded with gray shale, sandy shale, and coal beds.	(See Iles and Williams Fork Formations)	Rangely and Uinta Mts. region.	Bituminous		
	Km	Mancos Shale	Hilliard Shale in Wyoming north of Uinta Mts.	4,900± - Bass 5,300 - Rangeley	Dark gray marine shale; several thin-bedded silty tan sandstone beds in upper 1,000 feet.	Forms low rolling plains between more resistant formations. Susceptible to landsliding and slumping. Sandstone beds in upper part form low ridges and cliffs.	In broad southwestward-trending belt along Williams Fork, and in large area northwest of Steamboat Springs.		Gas shows	
		Niobrara Formation	(Mapped with Mancos Shale)	± 1,300 (600-700 ?	Limy shale interbedded with thin beds of platy fossiliferous limestone.	Weathers into very light gray limestone chips. More resistant than adjacent shale beds.	In Williams Park, just above Frontier. Four miles NE of Phippsburg.		Gas shows	
		Frontier Sandstone	(Same)	50± - (east) 150± - (west)	Thin-bedded, fine-grained fossiliferous limy sandstone.	Moderately high stability except where dip is steep. Stable foundation.	In Williams Park, about 330 ft. above base of Mancos. Uinta Mts. area.		Gas shows	
		Mowry Shale	(Same) Equivalent to basal part of Mancos	50-200	Marine shale, light to dark gray, but weathers distinctive silvery-gray. Hard, siliceous.	Weathers to chips and small fragments. Probably moderately high slope stability except on dip slopes.	Uinta Mts. mostly. Fish scales are diagnostic.		Oil shows	
Lower Cretaceous	Kd	Dakota Sandstone	Fuson Shale Lakota Sandstone	90-165	Sandstone, fine to coarse grained, hard, partly conglomerate some light to dark gray shale beds.	Generally forms massive ridge. Excellent for foundations except shale parts.	Water gap of Yampa River at Steamboat Springs.			Uranium minerals northeast of Meeker.

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)[1]	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Upper Cretaceous	Kls	Lewis Shale	Steel Shale	0- 1,900 ± 1,900 (central)	Dark gray to bluish marine shale; some large calcareous concretions; interfingers with Mesaverde increasingly westward.	Forms low rolling generally treeless country between more resistant formations. Very susceptible to slumping and landsliding; weathers pale yellow.	From near Lay east through Craig area, past Hayden southeast to Twentymile Park and Oak Creek; north from Hayden into Elkhead Mts. Not present south of Axial Basin.			
	Kwf	Williams Fork Formation of Mesaverde Group	Mesaverde Group	1,100 - (east) 1,700 - (central) 2,000 ± - (west)	Shale, thin and a few thick sandstone beds, sandy shale, and several coal beds. Thick Twentymile Sandstone Member near top. Red burned and baked areas common.	Generally forms slightly less rugged hills than Iles. Twentymile Sandstone Member forms conspicous cliffs. Relatively stable.	Forms bulk of Williams Fork Mts. and much of Danforth Hills.	Bituminous (some in upper part is subbituminous)		
	Ki	Iles Formation of Mesaverde Group	Mesaverde Group	1,500 - (east) 1,370 - (central)	Massive to slabby sandstone beds, light gray to brown and interbedded shale, siltstone and coal beds Trout Creek (top) and Tow Creek (base) Sandstone Members.	Generally forms rugged hills with numerous ledges and cliffs. Trout Creek Sandstone forms very conspicuous cliffs. Relatively stable.	Excellent exposures on Iles and Duffy Mts., Williams Fork Canyon, south slopes Williams Fork Mts. and Danforth Hills.	Bituminous		

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)[1]	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest: Coal (rank)	Deposits of Economic Interest: Oil( ) Gas( )	Deposits of Economic Interest: Other
Paleocene	Tfw	Fort Union Formation	Post-"Laramie" Formation (1924 report)	2,500 - (Powder Wash) 1,400 - (Craig) 1,675 - (west of Meeker)	Interbedded brown medium-to-coarse-grained sandstone, and coal beds; some of them quite thick; ferruginous layers.	Beds mostly poorly consolidated except for numerous ferruginous layers.	Brown and gray sandstone and shale with coal beds; thick sandstone beds in lower part.	Subbituminous		
	Toc	Ohio Creek Formation		0-50±	Light-brown to white sandstone, locally quartzitic, locally has chert pebbles or conglomerate.	Moderately resistant.	Known only in small areas, mostly near Strawberry Creek west of Meeker.			
Upper Cretaceous	Kl	Lance Formation	"Laramie" Formation (1924 and some older reports).	0-1,500	Interbedded gray shale, light tan soft finer-grained sandstone and a few coal beds, some quite thick. Thick coarse-grained white sandstone at top.	Beds mostly poorly consolidated.	From 4 miles north of Lay, in narrow belt eastward to just north to Elkhead Mts., also near Slater at State boundary.	Subbituminous	Gas shows	
		Fox Hills Sandstone	(Mapped with overlying Lance Formation)	0-50±	Sandstone, medium-grained, massive, white to gray.	Forms steep slope or cliff above soft Lewis Shale and below soft Lance beds.	Forms rim rock ½ mile north of Craig.			

TABLE III-1 (Cont.)

Geologic Formations of Northwest Colorado

Age	Map Symbol	Formation Name or Deposit	Former Name or Correlative in Adjacent Areas	Thickness (feet)[1]	Lithology	Possible Engineering Hazards or Outcrop Characteristics	Outcrop Areas or Notable Occurrences	Deposits of Economic Interest		
								Coal (rank)	Oil( ) Gas( )	Other
Eocene	Tu	Uinta Formation	Washakie Formation in Wyoming	0-360	Sandstone, brown to gray, medium to coarse-grained, interbedded with gray and brown calcareous shale.		Small area near Rangely.			
	Tb	Bridger Formation	Washakie Formation in Wyoming	0-375+	Tuffaceous claystone, lavender crossbedded sandstone, and gray cogwinal limestone.		Western Sand Wash Basin.			Zeolite (Clinoptilolite)
	Tg	Green River Formation	(Several members)	0-2,100±	Shale, oil shale, sandstone, and some limestone.		Western Sand Wash Basin. Also Gray Hills northwest of Meeker.			Oil shale, Sodium zeolite (analclime). Placer gold.
	Tw	Wasatch Formation	(Several members)	0-6,750±	Mostly medium to very coarse-grained conglomeratic sandstone interbedded with gray and red clays and mudstones. Local coal beds near Hiawatha only.	Mostly poorly consolidated.	Sand Wash Basin. Also Coyote Basin northwest of Meeker.	Subbituminous		Bituminous sandstone. Placer gold

Coal Production

APPENDIX D

TABLE OF CONTENTS
FOR
COAL PRODUCTION

Table	Title	Page
IV-1	Coal Produced (Short Tons) in Northwest Colorado from 1887 to January 1, 1975	IV-1-3

Coal Production

TABLE IV-1

Coal Produced (Short Tons) in Northwest Colorado From 1887 to Jan. 1, 1975

	Counties		
Year	Moffat	Rio Blanco	Routt
1887	---	---	---
1888	---	---	---
1889	---	2,900	1,491
1890	---	200	705
1891	---	---	---
1892	---	100	330
1893	---	---	816
1894	---	1,680	2,710
1895	---	1,761	2,767
1896	---	1,400	1,832
1897	---	1,882	945
1898	---	1,311	1,339
1899	---	--- 1/	1,211
1900	---	3,911 6/	1,375
1901	---	--- 1/	1,558
1902	---	--- 1/	3,180
1903	---	--- 1/	2,775
1904	---	---	5,568
1905	---	---	3,643
1906	---	--- 1/	5,297
1907	---	--- 1/	5,690
1908	---	--- 1/	13,005
1909	---	--- 1/	92,430
1910	---	--- 1/	258,452
1911	---	--- 1/	317,791
1912	---	--- 1/	448,261
1913	---	---	334,961
1914	---	--- 1/	666,384
1915	---	--- 1/	852,315
1916	---	--- 1/	915,028
1917	---	--- 1/	1,074,103
1918	---	1/	914,300

1/ Production summed with other counties

6/ Includes Jefferson County

Coal Production

TABLE IV-1 (Cont.)

Year	Moffat	Rio Blanco	Routt
	Counties		
1919	---	--- 1/	1,181,332
1920	---	6,472 3/	964,342
1921	---	--- 1/	880,015
1922	4,875	3,349	432,198
1923	--- 1/	3,706	803,455
1924	6,963	3,188	911,643
1925	7,188	6,264	1,009,703
1926	4,950	--- 1/	920,569
1927	3,913	4,598	925,633
1928	4,896	5,165	929,190
1929	5,853	5,977	1,006,157
1930	7,637	5,599	838,828
1931	5,147	6,931	570,886
1932	3,798	5,323	572,458
1933	2,606	4,264	467,551
1934	2,945	3,937	485,311
1935	6,804	4,518	789,905
1936	6,871	5,206	987,338
1937	18,229	4,320	1,024,621
1938	35,205	4,254	741,431
1939	55,900	--- 1/	727,440
1940	48,162	--- 1/	909,942
1941	49,459	57,358 4/	878,952
1942	65,817	15,064 5/	1,231,608 4/
1943	100,689 2/	50,869 4/	1,194,483
1944	138,394	54,497 4/	1,187,237
1945	128,594	40,796 4/	1,093,294
1946	142,023	11,927 4/	896,303
1947	146,494	23,572 4/	1,016,823
1948	144,288	35,142 4/	939,875
1949	130,404	48,050 4/	807,289
1950	125,743	73,611 5/	832,928

1/ Production summed with other counties

2/ Includes Jackson County

3/ Includes Moffat County

4/ Includes Montrose County

5/ Includes Montezuma County

Coal Production

TABLE IV-1 (Cont.)

	Counties		
Year	Moffat	Rio Blanco	Routt
1951	110,275	40,190 [5/]	678,698
1952	90,590	40,402	688,486
1953	90,660	23,266	616,164
1954	85,683	18,539	450,146
1955	100,556	20,047	522,942
1956	96,461	18,728	484,034
1957	108,025	12,902	458,964
1958	117,855	11,250	386,635
1959	120,463	10,841	389,695
1960	125,805	11,841	469,325
1961	117,257	10,643	446,355
1962	128,381	8,296	488,105
1963	158,298	6,587	786,815
1964	175,472	7,217	899,175
1965	194,672	6,112	1,347,634
1966	194,142	5,331	1,557,789
1967	215,997	4,964	1,814,484
1968	347,714	5,536	1,737,474
1969	383,041	5,352	1,784,697
1970	468,488	3,354	1,990,535
1971	448,982	770	1,710,386
1972	295,873	4,556	2,231,085
1973	289,560	329	2,606,025
1974	240,751	11,766	3,457,899
Total:	6,109,749	797,594	63,128,613

Total 69,035,956

[5/] Includes Montezuma County

Water Resources

APPENDIX D

TABLE OF CONTENTS
FOR
WATER RESOURCES

Table	Title	Page
V-1	Sediment Yield Computations 1976-80 (Regional Analysis Tables RV-2, RV1-1, RVII-1)	V-1
V-2	Sediment Yield Computations 1981-85 (Regional Analysis Tables RV-3, RVI-2, RVII-2)	V-3
V-3	Sediment Yield Computations 1986-90 (Regional Analysis Tables RV-4, RVI-3, RVII-3)	V-4
V-4	Physical Water Quality at Selected Stream Sites in the Analysis Area	V-5-6
V-5	Existing Reservoirs in Analysis Area and Capacity (Acre-Feet) of Each Reservoir	V-7-11
V-6	Evaluation of Discharges from Sewage Treatment Plants in the Analysis Area	V-12-14
V-7	Leading and Estimated Infiltration of Sewage Treatment Plants in the Analysis Area	V-15
V-8	Dissolved Solids in Selected Wells, Streams, and Mine Pits	V-16
V-9	Chemical Water Quality at Selected Stream Sites in the Analysis Area	V-17-18
V-10	Trace Elements Analyses for Several Stream Sampling Sites in April and May 1974	V-19
V-11	Concentration and Discharge of Dissolved Solids and Suspended Sediment for Streams in the Yampa River Basin	V-20
V-12	Biological Quality of Surface Water at Sites Sampled in the Study Region	V-21-25

Water Resources

Surface Water

Water Quality

Sediment Yield due to mining and associated activities is computed in the following three tables for the periods 1976-80, 1981-85, and 1986-90.

TABLE V-1
(Computations for Tables RV-2, RVI-1, RVII-1 Regional Analysis)
1976-80

Estimates and assumptions which were used to compute the total sediment yeild follow:

1) Surface mines:

4,825 x 1.7 x 2.7 = 22,100 tons

Where: 4,825 = Total acreage disturbed during 5-year period.

1.7 = Estimated sediment yield in acre-feet per square mile.

2.7 = Conversion factor to convert acre-feet per square mile to tons per acre.

2) Surface mines: revegetated:

1,434 = Total acreage revegetated during 5-year period.

770 = Total sediment yield computed using an integrated approach. Using one fifth of the area for each year and assuming that the first year's reclamation will be in effect for four years, the second for three years, etc., the total sediment yield was computed as follows:

2,870 x 0.1 x 2.7 = 770 tons

Where: 2,870 = Acre years revegetated.

0.1 = Estimated sediment yield in acre-feet per square mile.

2.7 = Conversion factor to convert acre-feet per square mile to tons per acre.

3) Underground mines:
200 x 0.8 x 2.7 = 430 tons
Where: 200 = Total acreage disturbed during 5-year period.
0.8 = Estimated sediment yield in ac-ft/sq. mi.
2.7 = Conversion factor.

4) Power Plants:
1000 x 0.8 x 2.7 = 2,160 tons
Where: 1000 = Total acreage disturbed during 5-year period.
0.8 = Estimated sediment yield in ac-ft/sq. mi.
2.7 = Conversion factor.

5) Roads, new:
420 x 1.7 x 2.7 = 1,930 tons
Where: 420 = Total acreage disturbed during 5-year period.
1.7 = Estimated sediment yield in ac-ft/sq. mi.
2.7 = Conversion factor.

6) Roads, revegetated:
250 = Total acreage revegetated during 5-year period.
270 = Total sediment yield computed using an integrated approach as explained for Surface mines, revegetated above.
500 x 0.2 x 2.7 = 270 tons
Where: 500 = Acre years revegetated during 5-year period.
0.2 = Estimated sediment yield in ac-ft/sq. mi.
2.7 = Conversion factor.

7) Railroads, new (W. R. Grace, Route A including area disturbed by rechannelization of Milk Creek in canyon:)
420 x 3.5 x 2.7 = 4,000 tons
Where: 420 = Total acreage disturbed.
3.5 = Estimated sediment yield in ac-ft/sq. mi.
2.7 = Conversion factor.

8) Railroads, revegetated:
420 = Total acreage revegetated during period.
1,160 = Total sediment yield computed using an integrated approach as explained for Surface mines, revegetated excepting that the railroad construction was assumed to take two years and revegetation was assumed to have been started in the third year during the 1976-80 period.
252 x 1.7 x 2.7 = 1,160 tons
Where: 252 = Acre years revegetated.
1.7 = Estimated sediment yield in ac-ft/sq. mi.
2.7 = Conversion factor.

9) Population:
1,070 x 0.8 x 2.7 = 2,310 tons
Where: 1,070 = Total acreage disturbed for housing and associated activities during 5-year period.
0.8 = Estimated sediment yield in ac-ft/sq. mi.
2.7 = Conversion factor.

10) Mine facilities:
400 x 1.7 x 2.7 = 1,840 tons
Where: 400 = Total acreage disturbed for mine maintenance building, etc. during 5-year period.
1.7 = Estimated sediment yield in ac-ft/sq mi.
2.7 = Conversion factor.

TABLE V-2

(Computations for Tables RV-3, RVI-2, RVII-2 Regional Analysis)
1981-85

Estimates and assumptions which were used to compute the total sediment yield follow:

1) Surface mines:
9,470 x 1.7 x 2.7 = 43,500 tons
Explanation same as for Table RV-2.

2) Surface mines, revegetated:
22,235 x 0.1 x 2.7 = 6,000 tons
Explanation same as for Table RV-2.

3) Underground mines:
300 x 0.8 x 2.7 = 650 tons
Explanation same as for Table RV-2.

4) Power plants:
1,000 x 0.8 x 2.7 = 2,160 tons
Explanation same as for Table RV-2.

5) Roads, new:
1,150 x 1.7 x 2.7 = 5,280 tons.
Explanation same as for Table RV-2.

6) Roads, revegetated:
2,950 x 0.2 x 2.7 = 1,590 tons
Explanation same as for Table RV-2.

7) Railroads, new:
60 x 2.0 x 2.7 = 320
Explanation same as for Table RV-2.

8) Railroads, revegetated:
2,260 x 1.7 x 2.7 = 10,400 tons.

9) Population:
No change during 5-year period.

10) Mine facilities:
300 x 1.7 x 2.7 = 1,380 tons
Explanation same as for Table RV-2.

TABLE V-3

(Computations for Tables RV-4, RVI-3, RVII-3 Regional Analysis)
1986-90

All items were computed as for those in Table RV-2. Figures used for items 2), 6) and 8) follow:

2) Surface mines, revegetated:
64,015 x 0.1 x 2.7 = 17,300 tons
Explanation same as for Table RV-2.

6) Roads, revegetated:
7,760 x 0.2 x 2.7 = 4,190 tons
Explanation same as for Table RV-2.

8) Railroads, revegetated:
7,536 x 1.7 x 2.7 = 34,600 tons.
Explanation same as for Table RV-2.

Tables RV-2, RVI-1, and RVII-1 as well as RV-3, RVI-2, and RVII-2, and RV-4, RVI-3, and RVII-3 are identical and are presented in three chapters to indicate total sediment yield, decrease due to mitigation, and residuals.

The figures of total sediment yield are explained above. The other two columns were obtained by applying estimated values for mitigation in percent and computing the decrease in yield and the difference of the total yield and decrease as the residual.

Water Resources

Surface Water Quality

TABLE V-4

Physical Water Quality at Selected Stream Sites in the Analysis Area

		Location		Field Observations			
STATION NAME 1/	DATE	PRINCIPAL MERIDIAN	TOWNSHIP AND RANGE	TEMPERATURE, °C	pH	SPECIFIC CONDUCTANCE MICROMHOS PER CENTIMETER AT 25°C	STREAM CONDITION 2/
MOFFAT COUNTY							
SF White R bl Swede C nr Buford, CO	10-19-71	S	T.1S.,R.91W.	4.0	7.8	300	--
Coal C bl Ninemile Draw nr Meeker, CO	10-19-71	S	T.2N.,R.92W.	7.0	7.8	450	--
Spring C tr nr Maybell, CO	5-18-72	S	T.7N.,R.95W.	--	--	--	NF
Jubb C nr mouth nr Axial, CO	5-17-72	S	T.5N.,R.93W.	--	--	--	NF
Wilson C ab Jubb C nr Axial, CO	5-17-72	S	T.5N.,R.93W.	16.5	8.4	2000	VST
Good Spring C at Axial, CO	5-17-72	S	T.4N.,R.93W.	18.0	8.5	1600	ST
Milk C ab Good Spring C at Axial, CO	5-17-72	S	T.4N.,R.92W.	14.0	8.3	335	SM VT
Deer C nr mouth nr Hamilton, CO	5-18-72	S	T.4N.,R.91W.	13.0	8.3	460	SM T
Morapos C nr Hamilton, CO	5-18-72	S	T.4N.,R.91W.	10.0	8.4	370	SM
Waddle C nr Hamilton, CO	6-6-72	S	T.4N.,R.90W.	15.0	8.0	750	IR OS
SF Williams F ab Pine C nr Pagoda, CO	6-5-72	S	T.3N.,R.90W.	10.0	8.0	150	SM OS
Yampa R tr nr Craig, CO	5-17-72	S	T.6N.,R.91W.	--	--	--	NF
Fortification C ab Ralph White Re, CO	5-18-72	S	T.8N.,R.90W.	11.0	8.1	180	SM VT
L Bear C ab Dry F in Craig, CO	5-17-72	S	T.8N.,R.90W.	12.5	7.9	100	SM T
Elkhead C at mouth of Elkhead, CO	6-6-72	S	T.7N.,R.90W.	19.5	7.6	225	SM T
RIO BLANCO COUNTY							
Stinking Water C at mouth nr Rangely, CO	5-15-72	S	T.1N.,R.102W.	29.0	8.9	8000	YT
Spring C nr Massadona, CO	5-15-72	S	T.2N.,R.101W.	13.5	8.2	8000	SF
L Spring C at mouth nr Massadona, CO	5-16-72	S	T.3N.,R.99W.	11.5	8.7	1880	ST
Strawberry C nr Meeker, CO	5-16-72	S	T.1N.,R.94W.	22.5	8.4	5450	ST
Sulphur C at mouth at Meeker, CO	5-16-72	S	T.1N.,R.94W.	--	--	--	NF
Curtis C at mouth nr Meeker, CO	5-16-72	S	T.1N.,R.94W.	18.0	8.1	7500	VST
EF Williams F ab Poose C nr Pagoda, CO	6-6-72	S	T.3N.,R.88W.	5.5	7.1	130	SM T
Trout C nr Source nr Oak Creek, CO	6-21-72	S	T.2N.,R.87W.	4.0	7.2	100	SM VST

1/, 2/ see page following.

Surface Water Quality

TABLE V-4 (Cont.)

Physical Quality at Selected Sites on Streams in the Analysis Area

		Location		Field Observations			
STATION NAME 1/	DATE	PRINCIPAL MERIDIAN	TOWNSHIP AND RANGE	TEMPERATURE °C	pH	SPECIFIC CONDUCTANCE, MICROMHOS PER CENTIMETER AT 25°C	STREAM CONDITION 2/
ROUTT COUNTY							
Beaver C at mouth nr Pagoda, CO	6-5-72	S	T.4N.,R.89W.	13.5	7.5	185	SM ST
Coal C at mouth nr Pagoda, CO	6-5-72	S	T.3N.,R.89W.	14.5	7.9	1600	SM VST
Elkhead C ab S F nr Elkhead, CO	6-7-72	S	T.9N.,R.87W.	20.0	7.7	120	SM VST
Sage C ab Lower Re nr Mt. Harris, CO	6-7-72	S	T.5N.,R.88W.	16.0	8.6	600	ST
Grassy C nr mouth nr Mt. Harris, CO	6-7-72	S	T.6N.,R.87W.	20.5	7.7	1100	T
Fish C at mouth nr Milner, CO	6-9-72	S	T.5N.,R.86W.	15.5	7.4	560	SM ST
Middle C nr mouth nr Milner, CO	6-9-72	S	T.5N.,R.86W.	15.0	7.2	550	SM T
Deep C bl Smith C nr Deep Creek, CO	6-15-72	S	T.8N.,R.86W.	24.5	8.3	300	--
Oak C bl Haybro, CO	6-9-72	S	T.5N.,R.85W.	15.0	6.7	580	SM T
Oak C bl Oak Creek, CO	6-9-72	S	T.4N.,R.85W.	16.0	8.0	390	SM T
Hunt C at mouth at Phippsburg, CO	6-21-72	S	T.3N.,R.85W.	18.5	8.1	580	SM ST
Yampa R tr nr Elkhead, CO	6-26-72	S	T.6N.,R.89W.	26.0	8.6	3000	YT

Source: U.S. Geological Survey, 1974

[1] Station Name: SF = South Fork, R = River, bl = below, C = Creek, nr = near, CO = Colorado, tr = tributary, ab = above, EF = East Fork, NF = North Fork

[2] Stream Conditions: IR, irrigation return flow suspected; NF, no flow; RO, runoff due to rain; SF, flow primarily from underground spring(s) just upstream; SM, runoff due to snowmelt. BGC, blue-gray coating on rocks; BOC, black-orange coating; GBC, gray-brown coating; OC, orange coating; OTC, orange-tan coating; RC, red coating; ROC, red-orange coating; TC, tan coating. BS, black stain on rocks; GBS, gray-brown stain; OS, orange stain; RS, red stain. BT, water has brown tinge; GT, gray tinge; GBT, gray-brown tinge; OT, orange tinge; WT, white tinge; YT, yellow tinge. VST, water is very slightly turbid; ST, slightly turbid; T, Turbid; VT, very turbid.

TABLE V-5

Existing Reservoirs in Analysis Area and Storage Capacity (Acre-Feet) of Each Reservoir

Name of Reservoir	Source	1973 Nov. 1	1974 May 1	1974 Oct. 31
District No. 43				
Beaver Lake Reservoir	Vaughan Creek	7.45	7.45	7.45
Big Beaver Creek Reservoir	Big Beaver Creek	6,000.	7,657.86	7,657.0
Big Lick Reservoir	Big Beaver Creek	400.	361.16	291.33
Cabin Lake Reservoir	Vaughan Creek	16.00	16.06	16.06
Gregor Reservoir	Vaughan Creek	47.0	47.0	47.0
Keystone Reservoir No. 3	Price Creek	3.5	31.8	11.0
Lady Lake Reservoir	Vaughan Creek	4.41	4.41	4.41
Larson Reservoir	Nineteen Mile Creek	61.9	61.9	61.9
Lunney Reservoir	Ninemile Draw	41.6	82.12	41.12
McHatton Reservoir	Coal Creek	Dry	Dry	Dry
Procter Reservoir	Curtis Creek	6.66	6.66	6.66
Seventh Lake Reservoir	Vaughan Creek	2.12	2.12	2.12
Stump Lake Reservoir	Vaughan Creek	10.23	10.23	10.23
West Miller Reservoir	West Miller Creek	29.8	77.8	48.
West Stewart Reservoir	West Stewart Creek	13.3	13.3	13.3
Wilson Reservoir	East Flag Creek	Dry	Dry	Dry
Black Gulch Reservoir	Black Gulch	Dry	Dry	Dry
District No. 44				
Anderson Reservoir	Cottonwood Creek	10.1	20.1	0
Biskup Reservoir	Biskup Gulch	0	135.8	0
Bunker Lake Reservoir	Bunker Creek	113.0	191.48	100.0
Cove Lake Reservoir	Morapos Creek	46.2	46.2	10.0
Cove Reservoir	Morapos Creek	67.7	67.7	67.7
D.D. & E. Reservoir	Hullett Draw	0	1,408.0	324.0

TABLE V-5 (Cont.)

Existing Reservoirs in Analysis Area and Storage Capacity (Acre-Feet) of Each Reservoir

Name of Reservoir	Source	1973 Nov. 1	1974 May 1	1974 Oct. 31
District No. 44 (Cont.)				
Dresher Reservoir	Lon Gulch	200.0	240.0	100.0
Dunkley Dubeau Reservoir	Willow Creek	112.0	112.9	40.9
Elgin Reservoir	Bell Rock Gulch	0	132.00	0
Elgin Reservoir N. 2	McLernon Draw	0	52.68	0
Freeman Reservoir	Little Cottonwood Creek	137.0	137.0	137.0
Konopil Reservoir	Clear Creek	0	13.3	0
Pitney Reservoir	Corral Gulch	0	11.23	11.23
Poose Creek Reservoir	Poose Creek	227.0	227.0	227.0
Ralph White Reservoir	Fortification Creek	605.0	605.0	605.0
Ruby Reservoir	Morapos Creek	0	26.0	0
Sellers Crowell Reservoir	Willow Creek	22.	106.	33.
Shafer Reservoir	Willow Creek	81.	81.	81.
Waddle Creek Reservoir	Waddle Creek	39.0	39.0	39.0
Wilson Reservoir	Good Springs Creek	68.0	68.0	68.0
Wyman Reservoir	Beaver Creek	95.7	95.7	95.7
District No. 54				
Cull Reservoir	Trib. Four Mile Creek	0	250.0	250.0
Elk Lake Reservoir	Willow Creek	0	199.2	398.4
Gold Blossom Reservoir	Gold Blossom Creek	0	0	0
Lake Fork Reservoir	Lake Fork Creek	44.3	44.3	44.3
Lower Cogdill Reservoir	Government Corral Creek	173.44	173.44	173.44
Perkins Fox Reservoir	Trib. West Willow Creek			
Skunk Creek Reservoir	Skunk Creek	15.32	15.32	15.32
Upper Cogdill Reservoir	Government Corral Creek	45.4	45.4	45.4

TABLE V-5 (Cont.)

Existing Reservoirs in Analysis Area and Storage Capacity (Acre-Feet) of Each Reservoir

Name of Reservoir	Source	1973 Nov. 1	1974 May 1	1974 Oct. 31
District No. 56				
Ainge Reservoir	Flynn Spring	.5	4.46	.5
Bassett Reservoir No. 1	Bull Canyon Gulch	0	0	0
Bassett Reservoir No. 2	Bull Canyon Gulch	40.0	54.0	40.0
Dry Lake Reservoir	Pot Creek	7.0	6.0	0
Haunted Spring Reservoir	Haunted Spring Gulch	.5	8.0	0
Massey Reservoir	Flynn Spring	5.0	7.0	0
Offield Reservoir	Pot Creek	64.0	50.0	5.0
T. W. Blevins Reservoir	Spring T. Vermillion Creek	3.0	4.0	6.0
District No. 57				
Greasewood Flats Reservoir	Dill Gulch	Dry	24.80	Dry
Apple Reservoir	Dry Creek	Dry	10.72	1.0
Ponds to Hayden Station	Yampa River	1,013.3	1,013.3	1,013.3
Brock Reservoir	Trib. To Yampa River	6.84	6.84	6.84
J.C. Temple Reservoir No. 1	Temple Gulch	87.0	553.0	70.0
J.M. Yoast Reservoir	Yoast Creek	Dry	147.0	Dry
Morgan Creek Reservoir No. 1	Morgan Creeek	51.6	320.0	12.3
Sage Creek Reservoir	Sage Creek	210.0	379.0	141.0
Seaton Reservoir	Middle Fish Creek	Dry	20.8	Dry
Sheriff Reservoir	Trout Creek	986.5	986.5	986.5
Yoast Reservoir No. 1, No. 2	Yoast Creek	Dry	6.83	Dry
District No. 58				
Allen Basin Reservoir	Middle Hunt Creek	1,023.	1,758.	790.
Alma Baer Reservoir	Fish Creek	0	0	0
Bear Lake Reservoir	Deadmans Creek	0	0	2.6

TABLE V-5 (Cont.)

Existing Reservoirs in Analysis Area and Storage Capacity (Acre-Feet) of Each Reservoir

Name of Reservoir	Source	1973 Nov. 1	1974 May 1	1974 Oct. 31
District No. 58 (Cont'd)				
Bison Park Reservoir	Lawson Creek	0	30.0	0
Bull Park No. 2 Reservoir	West Branch Watson Creek	0		
Burnt Mesa Reservoir	South Hunt Creek	0	40.0	30.0
Chapman Reservoir	Little Oak Creek	100.	246.	50.
Crowner Reservoir	Beaver Creek	0	58.	0
Fish Creek Reservoir	Fish Creek	1,175.	1,842.	1,426.
Fish Lake Reservoir No. 2	Wheeler Creek	35.0	35.0	35.
Franch Reservoir	Jack Creek	Empty	7.	3.
Gardner Reservoir	Gardner Creek	1,051.	1,155.	1,077.
Hahns Peak Reservoir	Willow Creek	600.5	600.5	600.5
Heart Lake Reservoir	Watson Creek	77.	283.	0
LaForce Reservoir No. 1	Jack Creek	-	2.	2.
LaForce Reservoir No. 2	Jack Creek	-	6.	4.
LaForce Reservoir No. 3	Jack Creek	-	6.	4.
Lake Creek Reservoir	Wheeler Creek	292.	292.	292.
Lake Windemere	Farnsworth Creek	137.4	137.4	137.4
Lee Reservoir	Chimney Creek	0	0	0
Lester Creek Reservoir	Lester Creek	5,657.	5,657.	5,657.
Long Lake Reservoir	Fish Creek	112.	395.65	62.
Lowry Reservoir	Pinnacle Creek	0	0	0
Martin Reservoir	Yellow Jacket Creek	20.0	80.0	10.
May Reservoir	Salt Creek	6.	6.	6.
McChivvis Reservoir	Watson Creek	0	191.	50.
Milk Creek Reservoir	Milk Creek	0	0	0
Moore Park Reservoir	Elgin Creek	0	20.	10.

TABLE V-5 (Cont.)

Existing Reservoirs in Analysis Area and Storage Capacity (Acre-Feet) of Each Reservoir

Name of Reservoir	Source	1973 Nov. 1	1974 May 1	1974 Oct. 31
District No. 58 (Cont'd)				
Oak Creek Reservoir	Oak Creek	3.	3.	3.
Osborn Reservoir	Raspberry Creek	0	0	0
Rams Horn Reservoir	Dome Creek	122.		
Reynolds Reservoir	Bruch Creek	0	0	0
Roland Reid Reservoir No. 1	Ft. Willy Gulch	45.	45.	45.
Sandelin Reservoir No. 1	Big Creek	2.5	2.5	2.5
Sandelin Reservoir No. 2	Big Creek	7.0	7.0	7.0
Sandelin Reservoir No. 3	Big Creek	6.8	6.8	6.8
Simon Reservoir	Middle Hunt Creek	455.	707.	440.
Stillwater Reservoir No. 1	Yampa River	3,711.	3,711.	3,070.
Stillwater Reservoir No. 3	Yampa River	620.	620.	620.
Stukey Distribution Reservoir	Spring Creek	4.6	4.6	4.6
Summer Reservoir	Young Creek	0	.20	.07
Tillquist Lake Reservoir	Morrison Creek	2.	5.	5.
Trull Creek Reservoir	Trull Creek	0	149.	0
Upper Willow Creek Reservoir	Willow Creek	23,604.	23,604.	23,604.
Wheeler Reservoir	Wheeler Creek	37.0	37.0	37.0
Willy Reservoir	Cow Creek	2.61	2.61	
Whitney Nelson Reservoir	Whipple Creek	200.	432.	300.
Younger Reservoir	Morrison Creek	Full	Full	Full

SOURCE: Colorado Division of Water Resources, 1974.

TABLE V-6

Evaluation of Discharges From Sewage Treatment Plants in the Analysis Area

Treatment Plant and Date	Dissolved Oxygen mg/l	Turbidity jtu	Solids		BOD5 mg/l	Fecal Coliform per 100 ml	Type of Sample
			Settleable mg/l	Suspended mg/l			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Health Dept. Standards	2.0	30	0.5	30	30	5,000	3-hour
Morrison Creek							
5-24-73	9.0	NA	0.1	31	NA	22	Grab
Timbers							
9-25-73	11.9	34	0.1	115	31	24,000	Grab
Oak Creek							
1-6-72	NA	NA	0.1	44	24	22,000	3-hour
4-6-72	NA	NA	0.6	40	17	NA	4-hour
7-26-72	NA	NA	0.0	5	16	2,000	6-hour
5-24-73	8.5	NA	0.1	28	28	22,000	6-hour
Mt. Werner							
1-5-72	NA	NA	0.1	33	48	2,400,000	6-hour
7-18-72	NA	NA	25.0	NA	67	NA	6-hour
1-10-73	4.6	102	0.1	41	63	480,000	6-hour
Fish Creek Park							
7-18-72	NA	NA	67.0	118	80	NA	6-hour
1-10-73	3.2	285	0.1	186	139	55,000	6-hour
5-24-73	3.9	12	0.1	50	23	2,200,000	6-hour

Abbreviations used: NA, not available; mg/l, milligrams per liter; jtu, Jackson Turbidity Units; BOD5, Biological Oxygen Demand 5-day

Water Quality

TABLE V-6 (Cont.)

Treatment Plant and Date	Dissolved Oxygen mg/l	Turbidity jtu	Solids Settleable mg/l	Solids Suspended mg/l	BOD5 mg/l	Fecal Coliform per 100 ml	Type of Sample
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bear Pole Ranch							
9-25-73	15.0	56	0.1	176	63	2	6-hour
Whiteman School							
9-25-73	10.4	29	0.2	202	117	22,000	6-hour
Steamboat Springs							
6-7-72	NA	NA	0.1	46	26	3,800	6-hour
7-19-72	NA	NA	7.0	17	35	NA	6-hour
1-9-73	5.4	33	0.0	27	26	45,000	6-hour
5-22-73	7.9	6	0.1	33	22	2,400	24-hour
9-25-73	3.3	9	0.1	23	13	2,200	22-hour
KOA Campground							
9-6-72	NA	NA	87.0	130	220	NA	Grab
1-11-73	NA	140	0.1	105	134	57,000	Grab
10-16-73	8.2	26	0.7	120	36	2,400	6-hour
Sleepy Bear Park							
1-5-72	NA	NA	0.1	45	48	2,400,000	6-hour
1-11-73	5.4	276	0.0	93	46	100	6-hour
5-22-73	0.7	NA	0.1	25	33	2,200	24-hour
Steamboat II							
6-7-72	NA	NA	0.1	25	11	15	Grab
9-6-72	NA	NA	18.0	32	13	NA	6-hour
1-9-73	5.2	57	0.7	80	48	127,000	6-hour
5-23-73	9.1	NA	0.2	31	16	2,200	6-hour
10-16-73	5.2	13	0.1	32	39	380	6-hour

Abbreviations used: NA, not available; mg/l, milligrams per liter; jtu, Jackson Turbidity Units; BOD5, Biological Oxygen Demand 5-day

TABLE V-6 (Cont.)

Treatment Plant and Date	Dissolved Oxygen mg/l	Turbidity jtu	Solids Settleable mg/l	Solids Suspended mg/l	BOD5 mg/l	Fecal Coliform per 100 ml	Type of Sample
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hayden							
4-6-72	NA	NA	0.6	40	17	NA	4-hour
5-21-72	NA	NA	5.0	9	21	5,400	6-hour
7-26-72	NA	NA	0.0	5	16	2,000	6-hour
5-8-73	4.2	NA	0.1	31	NA	22	Grab
Big Country Meats							
5-8-73	5.2	NA	0.3	166	NA	22	6-hour
Craig STP							
8-30-72	NA	52	28.0	42	20	2,000	Grab
5-8-73	15.0	NA	0.1	78	37	38,000	6-hour
10-17-73	8.8	14	0.1	24	12.5	2,200	8-hour
Meeker							
6-23-71	NA	NA	0.4	45	13	22,000	4-hour
8-15-72	NA	NA	80.0	451	243	22,000	Grab
9-12-72	NA	NA	50.0	295	91	22,000	6-hour
10-17-73	1.8	88	2.0	245	83	240	5-hour
Rangely							
9-10-70	NA	NA	0.1	74	16	30,000	Grab
12-2-70	NA	NA	0.1	43	29	30,000	Grab
8-15-72	NA	NA	0.1	25	15	2,200	Grab
5-10-73	14.2	NA	0.1	23	13.5	2,400	16-hour

SOURCE: Colorado State Health Department, 1974

Abbreviations used: NA, not available; mg/l, milligrams per liter; jtu, Jackson Turbidity Units; BOD5, Biological Oxygen Demand 5-day

TABLE V-7

Leading and Estimated Infiltration of Sewage Treatment Plants in the Analysis Area

Treatment Plant	Reported Design Capacity gpd	Reported Avg. Flow at Treatment Plant gpd	Estimated Population	Flow at 100 gpcd	Estimated Infiltration gpd	Index of Infiltration Col. (3) : Col. (5)	Estimated Economic Infiltration Reduction %	gpd	Estimated Infiltration After Correction gpd
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Oak Creek	250,000	250,000	700	70,000	180,000	3.57	60	108,000	72,000
Mt. Werner	65,000	250,000	700	70,000	180,000	3.57	60	108,000	72,000
Steamboat Springs	650,000	1,900,000	2,700	270,000	1,630,000	7.04	55	902,000	728,000
Hayden	250,000	600,000	1,300	130,000	470,000	4.62	65	305,000	165,000
Craig	600,000	660,000	4,600	460,000	200,000	1.44	NA	NA	200,000
Meeker	250,000	270,000	1,650	165,000	105,000	1.64	NA	NA	105,000
Rangely	300,000	200,000	1,600	160,000	40,000	1.25	NA	NA	40,000

SOURCE: Colorado State Health Department, 1974

Abbreviations used:
NA, Not available
Col., Column
gpd, gallons per day
gpcd, gallons per capita per day

TABLE V-8

Dissolved Solids in Selected Wells, Streams and Mine Pits

	Consolidation Fuels Test Holes 1	2	Energy 1 Pit 3	Foidel Creek Near Tipple 4	Foidel Creek Near Foidel School 5	Energy 2 Pit 6	Monitor Well P-2 7	Seneca 2 Pit 8	Seneca 2 Shop Well 9
Calcium mg/l	37	34	410	71	140	75	64	250	200
Magnesium mg/l	21	21	180	35	71	29	77	170	77
Potassium mg/l	13	3	6	3	3	3	4	10	4
Sodium mg/l	200	190	64	19	36	44	76	160	31
Bicarbonate mg/l	710	583	217	313	305	314	518	416	557
Chloride mg/l	4	3	7	4	6	7	4	18	21
Fluoride mg/l	0.8	1.3	0.3	0.3	0.3	0.3	0.1	0.4	0.3
Sulfate mg/l	39	120	1,500	84	430	80	220	1,300	420
NO_2 + NO_3 as ND mg/l	0.01	0.02	18	0.00	1.4	13	0.00	5.0	0.07
Silica mg/l	9.6	16	54	8.8	5.3	11	14	5.8	14
TDS mg/l	677	676	2,360	380	848	462	720	2,140	1,050
Arsenic µg/l	0	0	0	2	1	0	0	0	0
Cadmium µg/l	0	0	1	0	0	1	0	1	4
Cobalt µg/l	0	0	0	0	0	1	0	0	0
Copper µg/l	0	0	3	3	4	5	0	0	250*
Iron µg/l	2,200	390	40	110	90	60	2,000	30	90
Lead µg/l	0	1	0	0	0	0	0	1	0
Manganese µg/l	80	0	20	70	110	80	50	70	17
Mercury µg/l	0.0	0.0	0.0	0.0	10.2	0.0	0.1	0.0	0.0
Molybdenum µg/l	0	0	1	0	0	3	0	1	0
Nickel µg/l	2	0	9	4	2	3	1	14	0
Selenium µg/l	0	0	47*	0	3	0	0	5	4
Vanadium µg/l	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Zinc µg/l	8	10	20	10	8	4	2,200 [1/]	30	20
Conductivity	1,090	1,080	2,850	600	1,200	740	1,500	2,420	1,450
pH	7.7	7.6	7.6	7.8	8.1	7.8	6.9	7.5	7.5
SAR	6.5	6.3	0.7	0.5	0.6	1.1	1.5	1.9	0.5
Water Temperature	14.5	18.0	18.5	23.8	22.0	25.0	10.0	16.0	20.5

[1/] Excessive value (probably due to contamination of sample).

TABLE V-9

Chemical Water Quality at Selected Stream Sites in the Analysis Area

STATION NAME 2/	DATE	Location 1/		Trace Elements, Micrograms per Liter															
		PRINCIPAL MERIDIAN	TOWNSHIP AND RANGE	ARSENIC (As)	CADMIUM (Cd)	CHROMIUM (Cr)	COBALT (Co)	COPPER (Cu)	IRON (Fe)	LEAD (Pb)	MAGANESE (Mn)	MERCURY (Hg)	MOLYBDENUM (Mo)	NICKEL (Ni)	SELENIUM (Se)	SILVER (Ag)	VANADIUM (V)	ZINC (Zn)	SULFATE (SO_4), MILLIGRAMS PER LITER
MOFFAT COUNTY																			
Stinking Gulch at Iles Grove, CO	5-18-72	S	T.5N.,R.92W.	1	0	-	0	1	20	0	13	0.0	-	1	-	0	-	10	590
Good Spring C at Axial, CO	5-17-72	S	T.4N.,R.93W.	0	0	-	0	1	20	3	80	0.0	-	4	-	0	-	10	540
Coal Gulch nr Craig, CO	5-18-72	S	T.8N.,R.90W.	5	0	-	0	3	20	1	25	0.2	-	8	-	0	-	30	1200
Deacon Gulch nr Craig, CO	6-6-72	S	T.6N.,R.90W.	3	0	-	0	0	10	1	490	0.0	-	5	-	0	-	20	2000
RIO BLANCO COUNTY																			
Spring C nr Massadona, CO	5-15-72	S	T.2N.,R.101W.	1	0	-	3	1	130	3	1200	0.0	-	12	-	0	-	20	4700
Yellow C nr White River, CO	5-16-72	S	T.2N.,R.98W.	4	0	-	0	2	10	2	0	0.0	-	2	-	0	-	10	660
Crooked Wash at mouth nr Massadona, CO	5-16-72	S	T.3N.,R.98W.	3	0	-	0	5	20	1	25	0.0	-	6	-	0	-	20	1300

1/, 2/ see page following

TABLE V-9 (Cont.)

Chemical Quality at Selected Stream Sites in the Analysis area

STATION NAME 2/	DATE	Location 1/		Trace Elements, Micrograms per Liter															
		PRINCIPAL MERIDIAN	TOWNSHIP AND RANGE	ARSENIC (As)	CADMIUM (Cd)	CHROMIUM (Cr)	COBALT (Co)	COPPER (Cu)	IRON (Fe)	LEAD (Pb)	MAGANESE (Mn)	MERCURY (Hg)	MOLYBDENUM (Mo)	NICKEL (Ni)	SELENIUM (Se)	SILVER (Ag)	VANADIUM (V)	ZINC (Zn)	SULFATE (SO_4), MILLIGRAMS PER LITER
ROUTT COUNTY																			
Cedar C at mouth nr Pagoda, CO	6-5-72	S	T.3N.,R.89W.	2	0	-	0	1	20	3	0	0.0	-	3	-	0	-	0	130
Coal C at mouth nr Pagoda, CO	6-5-72	S	T.3N.,R.89W.	0	0	-	0	1	30	1	38	0.0	-	4	-	0	-	20	690
Grassy C nr mouth nr Mt. Harris, CO	6-7-72	S	T.6N.,R.87W.	0	0	-	0	0	20	1	810	0.0	-	6	-	0	-	10	300
Trout C ab Middle C nr Milner, CO	6-9-72	S	T.5N.,R.85W.	1	0	-	0	1	130	2	0	0.0	-	3	-	0	-	30	15
Oak C Drain nr Oak Creek, CO	6-9-72	S	T.4N.,R.85W.	1	0	-	1	0	7000	3	180	0.0	-	12	-	0	-	40	1600

SOURCE: U.S. Geological Survey, 1974

1/ PRINCIPAL MERIDIAN: NM, New Mexico; S, Sixth; U, Ute.

2/ STATION NAME: ab, above; bl, below; Bk, Brook; Cn, Canyon; CO, Colorado; Co., County; C, Creek; di, distributary; D, Ditch; E, East: F, Fork; Ft., Fort; Gdn, Golden; Gl, Gulch; Hwy, Highway; Lk, Lake; L, Little; M, Middle; mo, mouth; Mtn, Mountain; nr, near; No., Number; Re, Reservoir; R, River; St., Saint; stp, sewage treatment plant; S, South; Spgs, Springs; tr, tributary; U.S., United States; W, West.

TABLE V-10

Trace Element Analyses for Several Stream Sampling Sites in April and May 1974

Parameters	Upper Dry Creek	Northern Tributary To Dry Creek	Lower Dry Creek	Upper Sage Creek	Below Sage Creek Reservoir	Lower Sage Creek	Grassy Creek
Date of collection	4-30-74	5-29-74	4-30-74	4-30-74	4-30-74	4-30-74	4-30-74
Fluoride (mg/l)	.18	.21	.30	.11	.13	5.22	.13
Aluminum (µg/l)	100	900	9,800	<100	<100	2,400	4,200
Copper (µg/l)	<10	10	20	<10	<10	<10	<10
Nickel (µg/l)	37	<33	74	<37	<37	74	<37
Manganese (µg/l)	0	90	610	0	330	320	180
Iron (µg/l)	120	970	17,600	40	380	4,300	6,400
Zinc (µg/l)	100	8	185	105	90	135	160
Cadmium (µg/l)	<9	<9	<9	<9	<9	<9	<9
Chromium, Total (µg/l)	15	<13	30	15	20	10	10
Lead (µg/l)	16	54	58	8	24	41	33
Mercury (µg/l)	0	-	.06	.01	.01	.04	.06
Arsenic (µg/l)	<1	2.7	11	<1	<1	3	3
Selenium (µg/l)	<1	<3	<1	<1	<1	<1	<1
Calcium (mg/l)	55	160	80	30	90	50	30
Magnesium (mg/l)	34	180	52	16	47	30	22
Sodium (mg/l)	24	140	20	7	18	18	26
Antimony (µg/l)	<0.8	<3	<0.8	<0.8	<0.8	<0.8	<0.8
Potassium (mg/l)	6	25	7	3	4	6	8
Silver (µg/l)	<5	-	12	<5	<5	<5	<5
Boron (µg/l) 1/	-	-	-	-	-	-	-
Vanadium (µg/l)	<100	<100	<100	<100	<100	<100	<100
Lithium (µg/l)	<25	70	25	<25	<25	<25	<25
Beryllium (µg/l)	<10	<10	<10	<10	<10	<10	<10
Molybdenum (µg/l)	24	<32	<24	<24	<24	<24	<24
Cobalt (µg/l)	<29	<34	59	29	<29	<29	<29

1/ Values obtained for this parameter appeared to be in error and will be compared with later analyses before being reported.

TABLE V-11

Concentration and discharge of dissolved solids and suspended sediment for streams in the Yampa River Basin. (Data represent annual average for the water years 1914 - 57 adjusted to 1957 conditions.)

Stream	Water discharge (thousands of acre-feet per year	Dissolved solids			Suspended sediment		
		Weighted-average concentration (ppm)	Discharge		Weighted-average concentration (ppm)	Discharge	
			Thousands of tons per year	Tons per square mile per year		Thousands of tons per year	Tons per square mile per year
Yampa River near Oak Creek	63.	221	19.	84	--	--	--
Yampa River at Steamboat Springs	342.	74	34.	57	--	--	--
Elk River at Clark	258.	40	14.	67	--	--	--
Elk River near Trull	394.	47	25.	61	--	--	--
Fortification Creek near Craig	9.7	774	10.	298	--	--	--
Williams Fork at Hamilton [1/]	158.	234	50.	148	--	--	--
Yampa River near Maybell	1,152.	140	219.	61	196	308	90
Little Snake River near Slater	188.	78	20.	70	--	--	--
Slater Fork near Slater	61.	101	8.4	52	212	18	109
Little Snake River near Lily	451.	196	120.	36	1,790	1,099	295

[1/] For 1905 - 06, 1910 - 27 water years

SOURCE: U.S. Geological Survey, 1974

Abbreviations used: ppm, parts per million

TABLE V-12

Biological Quality of Surface Water at Sites Sampled in the Study Region

See bottom of last page of table for legend.

Location 2/				Aquatic Organisms 3/											
				Flora				Fauna							
Station Name 1/	Date	Principal Meridian	Township and Range	Rooted Aquatics	Diatoms	Green Algae	Blue-green Algae	Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches
Moffat County															
Spring C ab unnamed tr nr Maybell, CO	5-18-72	S	T7NR95W	A	P-C	P	A	A	A	P	A	P	P	A	A
Wilson C ab Jubb C nr Axial, CO	5-17-72	S	T4NR93W	A	C	P	A	C	P-C	C	A	A	A	P	A
Milk C ab Good Spring C nr Axial, CO	5-17-72	S	T4NR92W	A	C	A	A	P-C	P	A	A	A	A	A	A
Deer C nr mouth at Hamilton, CO	5-18-72	S	T4NR91W	A	P-C	P	A	C	P	P	A	A	A	A	A
Morapos C nr Hamilton, CO	5-18-72	S	T4NR91W	A	C	A	A	P-C	A	P	A	P	P-C	P	A
Pine C at mouth nr Pagoda, CO	6-5-72	S	T4NR91W	A	P	P	A	P	P-C	P	A	P	C+	A	A
Fortification C ab Ralph White Re, CO	5-18-72	S	T8NR90W	-	-	-	-	P	A	A	A	A	A	A	A
L Bear C ab Dry F nr Craig, CO	5-17-72	S	T8NR90W	A	P-C	A	A	A	A	A	A	A	P	A	A
Dry F L Bear C at mouth nr Craig, CO	5-17-72	S	T8NR90W	A	C	A	A	A	P	P	A	P-C	A	A	A
Elkhead C at mouth at Elkhead, CO	6-6-72	S	T7NR90W	A	C	P	A	P	P	P	A	P	C	A	A

TABLE V-12 (Cont.)

Biological Quality of Surface Water at Sites Sampled in the Study Region

See bottom of last page of table for legend.

Location 2/				Flora				Fauna							
Station Name 1/	Date	Principal Meridian	Township and Range	Rooted Aquatics	Diatoms	Green Algae	Blue-green Algae	Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches
Rio Blanco County															
SF White R bl Swede C nr Buford, CO	10-19-71	S	T15R91W	A	P-C	P	A	C	C	C	A	A	A	A	A
Coal C bl Ninemile Draw nr Meeker, CO	10-19-71	S	T2NR92W	A	P-C	P-C	A	C	C	C	A	A	A	C	A
Trull C at mouth nr Milner, CO	10-15-71	S	T7NR85W	P	A	C	A	P	P	A	A	A	A	C	A
Willow C at mouth nr Clark, CO	10-14-71	S	T9NR85W	A	P(?)	P	A	C	C	C	A	A	A	A	A
Beaver C at mouth nr Hahns Peak, CO	10-14-71	S	T9NR85W	P-C	A	P-C	A	C	C	C	A	A	A	A	A
Stinking Water C at mouth nr Rangely, CO	5-15-72	S	T1NR102W	A	P-C	A	A								
Douglas C nr mouth nr Rangely, CO	5-15-72	S	T1NR101W	A	P	P-C	A	C	A	A	A	P	A	A	A
E Douglas C at mouth nr Rangely, CO	5-15-72	S	T25R101W	-	-	-	-	A	A	P	A	P	A	A	A
Spring C nr Massadona, CO	5-15-72	S	T2NR101W	A	P-C	P-C	A	A	A	A	A	P-C	A	A	A
L Spring C at mouth nr Massadona, CO	5-16-72	S	T3NR99W	P	P-C	P-C	A	A	A	P	A	P	P	A	A

Aquatic Organisms 3/

TABLE V-12 (Cont.)

Biological Quality of Surface Water at Sites Sampled in the Study Region

See bottom of last page of table for legend.

Location 2/				Aquatic Organisms 3/ Flora				Aquatic Organisms 3/ Fauna							
Station Name 1/	Date	Principal Meridian	Township and Range	Rooted Aquatics	Diatoms	Green Algae	Blue-green Algae	Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches
Rio Blanco County (Contd)															
Strawberry C nr Meeker, CO	5-16-72	S	T1NR94W	A	P(?)	A	A	A	P	A	A	A	A	A	A
Flag C ab Meeker, CO	5-16-72	S	T1SR94W	A	C	A	A	-	-	-	-	-	-	-	-
Curtis C at mouth nr Meeker, CO	5-16-72	S	T1NR94W	A	C	P	A	A	A	P	A	A	A	P	A
L Beaver C at mouth nr Meeker, CO	5-16-72	S	T1NR93W	-	-	-	-	A	A	A	A	P-C	A	P	A
EF Williams F ab Poose C nr Pagoda, CO	6-6-72	S	T3NR88W	-	-	-	-	P-C	P	A	A	A	C	A	A
Trout C nr source nr Oak Creek, CO	6-21-72	S	T2NR87W	A	C	A	A	P-C	P	P	A	A	P	A	A
Routt County															
Beaver C at mouth nr Pagoda, CO	6-5-72	S	T4NR89W	A	P	A	A	P	C	C	A	P	C	A	A
Coal C at mouth nr Pagoda, CO	6-5-72	S	T3NR89W	A	A	P-C	A	A	A	P-C	A	A	A	A	A
Dry F Elkhead C at mouth nr Elkhead, CO	6-6-72	S	T8NR88W	P	C	P	A	A	P	P-C	A	P-C	C	A	A

TABLE V-12 (Cont.)

Biological Quality of Surface Water at Sites Sampled in the Study Region

See bottom of last page of table for legend.

Aquatic Organisms 3/

Location 2/				Flora				Fauna							
Station Name 1/	Date	Principal Meridian	Township and Range	Rooted Aquatics	Diatoms	Green Algae	Blue-green Algae	Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches
Routt County (Contd)															
NF Elkhead C at mouth nr Elkhead, CO	6-6-72	S	T8NR88W	A	C	P	A	P	P	P	A	P-C	C	A	A
SF Elkhead C nr mouth nr Elkhead, CO	6-7-72	S	T9NR87W	A	C	P	A	P	P	P-C	A	P	P	A	A
Dry Creek nr Hayden, CO	6-7-72	S	T5NR88W	-	-	-	-	P-C	A	P	P	A	P-C	A	A
Sage Cab Lower Re nr Mt. Harris, CO	6-7-72	S	T5NR88W	A	C	A	A	P	P	C	A	P	A	A	A
Grassy C nr mouth nr Mt. Harris, CO	6-7-72	S	T6NR87W	A	P(?)	A	A	A	A	P-C	A	P	A	A	A
Fish C at mouth nr Milner, CO	6-9-72	S	T5NR86W	A	C	P	A	P-C	A	P	A	P	P	A	A
Middle C nr mouth nr Milner, CO	6-9-72	S	T5NR86W	P	C	P	A	P	A	P	A	P-C	A	A	A
Trout C ab Middle C nr Milner, CO	6-9-72	S	T5NR85W	A	C	P	A	P	P	P	A	P	P	A	A
Oak C bl Haybro, CO	6-9-72	S	T5NR85W	P	C	A	A	P	A	C	A	P	A	P	A

TABLE V-12 (Cont.)

Biological Quality of Surface Water at Sites Sampled in the Study Region

Location 2/				Aquatic Organisms 3/ Flora				Fauna							
Station Name 1/	Date	Principal Meridian	Township and Range	Rooted Aquatics	Diatoms	Green Algae	Blue-green Algae	Mayflies	Stoneflies	Caddisflies	Beetle Larvae	Midges	Black Flies	Snails	Leeches
Routt County (Contd)															
SF L Snake R at mouth nr Columbine, CO	6-8-72	S	T12NR86W	A	C	P	A	P	P	C	P(?)	P	P	P	A
Slater F ab S F nr Slater, CO	6-8-72	S	T10NR88W	A	C	P	A	A	P	P-C	A	P	P-C	A	A

SOURCE: D.A. Wentz, 1974

1/ STATION NAME: ab, above; bl, below; bk, Brook; Cn, Canyon; CO, Colorado; Co., County; C, Creek; di, distributary; D, Ditch; E, East; F, Fork; Ft., Fort; Gdn, Golden; Gl, Gulch; Hwy, Highway; Lk, Lake; L, Little; M, Middle; mo, mouth; Mtn, Mountain; nr, near; N, North; No., Number; Re, Reservoir; R, River; St., Saint; stp, sewage treatment plant; S, South; Spgs, Springs; tr, tributary; U.S., United States; W, West.

2/ PRINCIPAL MERIDIAN: NM, New Mexico; S, Sixth; U, Ute.

3/ AQUATIC ORGANISMS ("10-rock" riffle sample unless otherwise specified under Miscellaneous): A, absent; 1, one organism observed; P, present; P-C, present to common; C, common; C+, abundant; (?), classification questionable; *, no suitable riffle for sampling rocks.

Air Quality

APPENDIX D

TABLE OF CONTENTS
FOR
AIR QUALITY

Page

Regional Emissions-- VI-1
Site Specific Emissions-- VI-19
  Introduction--- VI-19
  Fugitive dust-- VI-24
  Fugitive dust off-mine roads-- VI-26
  Process emissions-- VI-27
  Vehicle exhaust--- VI-28
Modeling Techniques--- VI-30
  Model description-- VI-30
    The calculation of short-term concentrations -
      sector averaging--- VI-34
    Trapping-- VI-40
    Calculation of annual averages---------------------------------- VI-41
  Model application-- VI-42
    Gaussian plume assumptions------------------------------------- VI-48
    Rough terrain-- VI-49
    Meteorological specifications---------------------------------- VI-49
Air Quality Standards-- VI-55

APPENDIX D

TABLE OF CONTENTS
FOR
AIR QUALITY

Table	Title	Page
VI-1	Projected 1974 Emissions from Commercial, Industrial, and Residential Fuel Use	VI-5
VI-2	Projected 1980 Emissions from Commercial, Industrial, and Residential Fuel Use	VI-6
VI-3	Projected 1985 Emissions from Commercial, Industrial, and Residential Fuel Use	VI-7
VI-4	Projected 1990 Emissions from Commercial, Industrial, and Residential Fuel Use	VI-8
VI-5	Emissions Factors Used to Develop Road Vehicle Emissions in the Tri-County Area (gm/km)	VI-9
VI-6	Projected Vehicle Emissions from 1974 Road Travel in the Tri-County Study Area	VI-10
VI-7	Projected Vehicle Emissions from 1980 Road Travel in the Tri-County Study Area	VI-11
VI-8	Projected Vehicle Emissions from 1985 Road Travel in the Tri-County Study Area	VI-12
VI-9	Projected Vehicle Emissions from 1990 Road Travel in the Tri-County Study Area	VI-13
VI-10	Projected Emissions from Railroads in the Tri-County Region (gm/sec)	VI-14
VI-11	Projected Suspended Particulate Emissions from Materials Handling	VI-15-16
VI-12	Within Mine Vehicle Emissions (metric tons/year)	VI-17
VI-13	Quantity of Material That Would Be Handled (metric tons/year) at Each Coal Mine Included in the Regional Impact Statement	VI-18
VI-14	Formulas for Calculating Emissions	VI-20
VI-15	Definitions and Numerical Values of Emission Calculation Parameters	VI-21-23
VI-16	A General Key to the Turner Stability Classification System	VI-33

APPENDIX D

TABLE OF CONTENTS
FOR
AIR QUALITY

Table	Title	Page
VI-17	Dispersion Parameters Used in Calculating Vertical Dispersion Plume from Area Sources	VI-37
VI-18	Mean Mixing Heights (meters) in Northwestern Colorado (Holzworth 1972)	VI-43
VI-19	Frequency of Stability Classes at Several Locations in Northwestern Colorado	VI-45
VI-20	Frequency of Wind Speed Classes Within Each Stability Class for Down-Valley Flow	VI-46
VI-21	Natural Ambient Air Quality Standards	VI-55
VI-22	Ambient Air Standards for Metropolitan Denver Air Quality Control Region, Air Quality Control Areas, and the State of Colorado	VI-56
VI-23	Allowable Incremental Increases for Class I and Class II Areas	VI-57

APPENDIX D

TABLE OF CONTENTS
FOR
AIR QUALITY

Figure Title Page

VI-1 Areas for which emissions from external fuel consumption were estimated-- VI-3

VI-2 Road links, railroad links and urban areas for which vehicle emissions were estimated------------------------ VI-4

VI-3 Coordinate system showing Gaussian distributions in the crosswind and vertical directions---------------------- VI-31

VI-4 Geometry of the linear interpolation between adjacent wind direction sectors------------------------------------ VI-36

VI-5 Geometry for area source with dimensions g_1 and g_2 in the horizontal plane, shown in the receptor-centered wind oriented coordinate system------------------------ VI-39

VI-6 Wind rose for unstable conditions------------------------ VI-51

VI-7 Wind rose for transition conditions---------------------- VI-52

VI-8 Wind rose for neutral conditions------------------------- VI-53

VI-9 Wind rose for stable conditions-------------------------- VI-54

Air Quality

Regional Emissions

Appendix D provides detailed tabulations of emissions from secondary fuel use, transportation systems, and mining activities in Routt, Rio Blanco, and Moffat Counties. Projected emissions for the years 1974, 1980, 1985, and 1990 are given by road link or area source. The size of the area sources and length of each road link are given as they were included in the computer model ERTAQ.

Figure VI-1 illustrates the 18 area sources into which secondary emissions from external fuel use were placed. Tables VI-1 through VI-4 show the projected emissions from each area for the four base years. The 1974 emissions were extracted from the National Emissions Data System (NEDS). Emissions for future years were computed by assuming a linear relationship between emissions and population.

Figure VI-2 illustrates the 14 highway links, 3 railway links, and 6 urban area sources for which vehicle exhaust emissions were computed. The proposed W. R. Grace Railway and the unpaved Seneca 2-W haul road are also shown. Vehicle exhaust emissions were computed using Environmental Protection Agency (EPA) emissions factors (1973a). Those for road traffic are shown in Table VI-5. Emissions from each link or urban area source are shown in Tables VI-6 through VI-9. The number of cars per day on each highway link in 1974 was extracted from a Colorado Department of Motor Vehicles traffic count. For the projection years, the traffic on each link was increased according to the regional population increase. Potential emissions from the urban area sources were computed by assuming that there were .6 cars/person in each town and that each car traveled 42 kilometers/day. Potential emissions from the railroads were computed using EPA (1973a) emissions factors for diesel locomotives. The results are shown in Table VI-10.

Potential emissions from materials handling at each mine required an estimate of quantity of materials that would be handled. Estimates of coal that would be mined, topsoil and overburden that would be moved at each mine are shown in Table VI-11. Topsoil was assumed to be .3 meters deep at all surface mines, and the overburden stripping ratio was assumed to be 6 cubic yards/ton of coal if an exact value was not known. Potential emissions from surface mines were computed using an emissions factor of .0055 percent of material that would be handled, derived from several reports on fugitive dust emissions (Cowherd, 1974; EPA, 1973; PEDCo, 1973). Potential fugitive dust emissions from underground mining were computed using an emissions factor of .0025 percent of coal mined. Potential emissions of fugitive dust as suspended particulate matter are shown in Table VI-12 for each mine.

Table VI-13 shows potential vehicle exhaust emissions from trucks and cars within each mine. They were computed from the EPA (1973a) emissions factors.

Potential suspended particulate emissions for unpaved roads were estimated by assuming that one kilogram is emitted/vehicle-kilometer traveled (PEDco, 1973). This factor was applied to within mine travel and to the Seneca 2-W haul road.

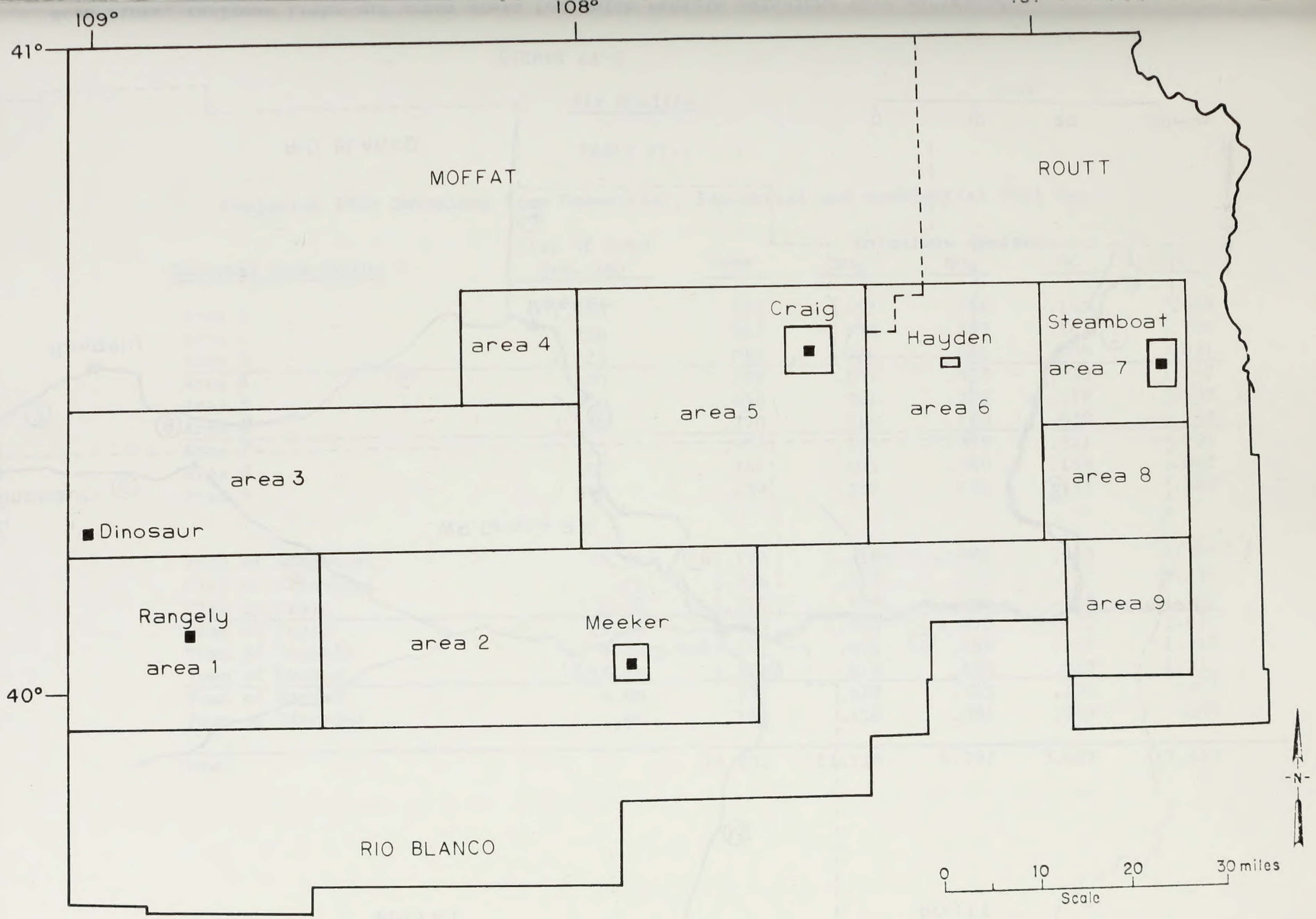


FIGURE VI-1

Areas for which emissions from external fuel consumption were estimated.

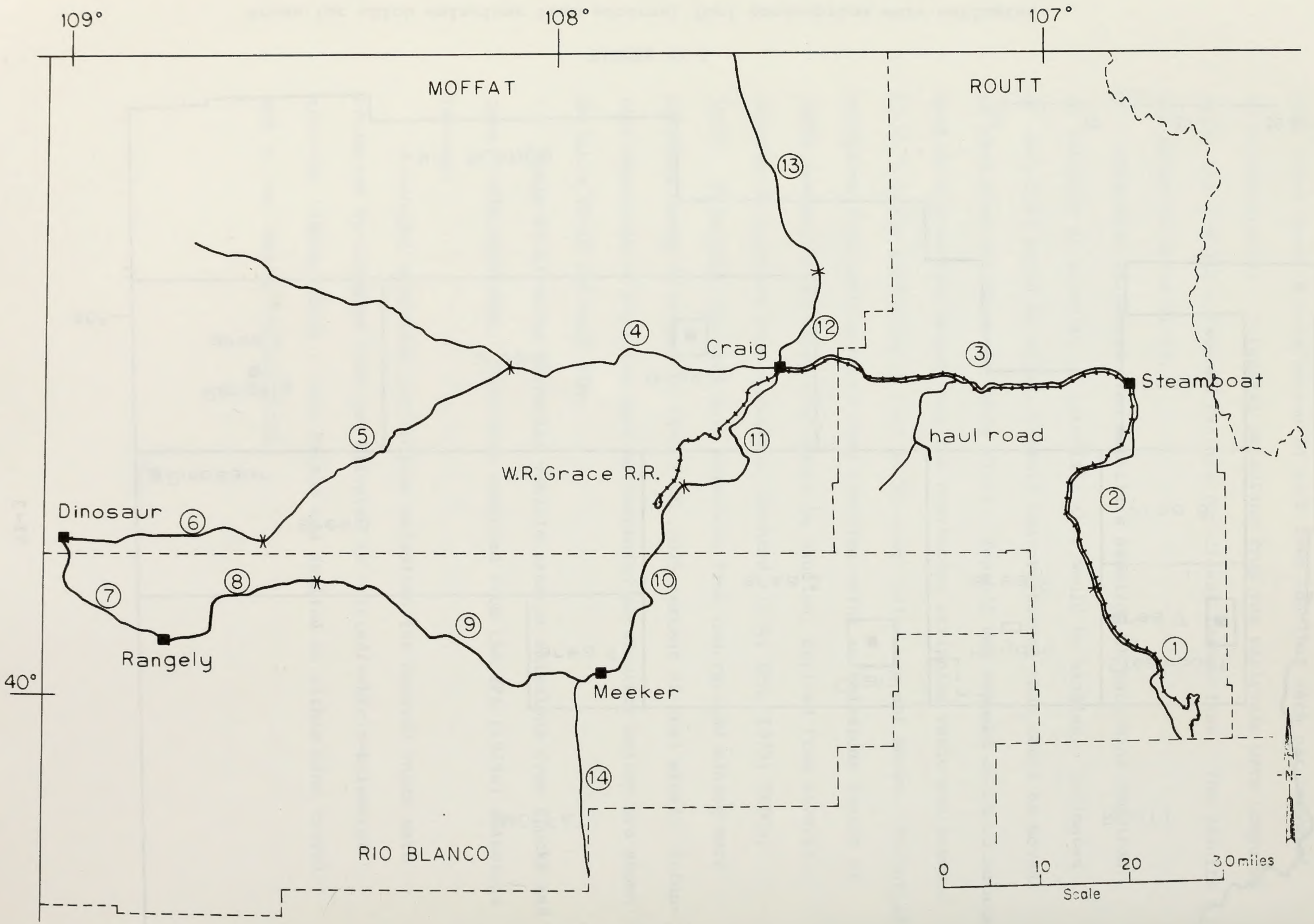


FIGURE VI-2

Road links. railroad links and urban areas for which vehicle emissions were estimated.

TABLE VI-1

Projected 1974 Emissions from Commercial, Industrial and Residential Fuel Use

External Combustion	Size of Area (sq. km)	Emissions (gm/sec) TSP	SO_x	NO_x	HC	CO
Area 1	1,350	.572	.452	.254	.148	.629
Area 2	2,250	.643	.508	.285	.167	.706
Area 3	2,225	.033	.026	.015	.009	.037
Area 4	400	.129	.102	.057	.033	.142
Area 5	2,250	.456	.361	.202	.118	.502
Area 6	1,350	.270	.214	.120	.070	.297
Area 7	625	.854	.675	.379	.221	.939
Area 8	500	.766	.605	.340	.199	.842
Area 9	500	.439	.352	.197	.115	.489
Area of Steamboat	15.36	2.173	1.718	.964	.563	2.389
City of Steamboat	.73	1.086	.859	.482	.282	1.194
City of Craig	1.13	1.214	.960	.538	.315	1.335
Area of Craig	16.16	2.429	1.920	1.077	.630	2.670
Town of Rangely	9.00	1.102	.871	.489	.286	1.212
Town of Meeker	16.16	1.106	.874	.490	.287	1.216
Town of Hayden	6.00	.732	.579	.325	.190	.805
Town of Dinosaur	.64	.189	.150	.084	.049	.208
Total		14.202	11.228	6.297	3.682	15.613

TABLE VI-2

Projected 1980 Emissions from Commercial, Industrial and Residential Fuel Use

External Combustion	Size of Area (sq. km)	Emissions (gm/sec) TSP	SO_x	NO_x	HC	CO
Area 1	1,350	.661	.522	.294	.173	.728
Area 2	2,250	.743	.586	.330	.194	.818
Area 3	2,225	.029	.023	.013	.008	.032
Area 4	400	.112	.088	.050	.029	.123
Area 5	2,250	.397	.313	.177	.104	.437
Area 6	1,350	.301	.238	.134	.079	.332
Area 7	625	.953	.752	.424	.429	1.049
Area 8	500	1.437	1.133	.639	.376	1.582
Area 9	500	.525	.414	.234	.138	.578
Area of Steamboat	15.36	4.230	3.336	1.882	1.108	4.657
City of Steamboat	.73	2.115	1.668	.941	.554	2.329
City of Craig	1.13	3,095	2.441	1.377	.810	3.408
Area of Craig	16.16	6.190	4.881	2.753	1.621	6.814
Town of Rangely	9.0	3.012	2.375	1.340	.789	3.316
Town of Meeker	16.16	5.437	4.288	2.418	1.424	5.986
Town of Hayden	6.0	2.020	1.59	.899	.529	2.22
Town of Dinosaur	.64	.442	.349	.197	.116	.487
Total		31.7	25.0	14.1	8.3	34.9

TABLE VI-3

Projected 1985 Emissions from Commercial, Industrial and Residential Fuel Use

External Combustion	Size of Area (sq. km)	Emissions (gm/sec) TSP	SO_x	NOx	HC	CO
Area 1	1,350	.776	.612	.345	.203	.853
Area 2	2,250	.871	.688	.387	.228	.957
Area 3	2,225	.034	.027	.015	.009	.037
Area 4	400	.132	.105	.059	.035	.146
Area 5	2,250	.467	.369	.208	.122	.514
Area 6	1,350	.536	.424	.238	.140	.590
Area 7	625	1.699	1.342	.756	.444	1.869
Area 8	500	1.731	1.367	.770	.453	1.903
Area 9	500	.605	.478	.269	.158	.665
Area of Steamboat	15.36	4.928	3.892	2.192	1.288	5.419
City of Steamboat	0.73	2.464	1.946	1.096	.644	2.710
City of Craig	1.13	2.750	2.172	1.223	.719	3.024
Area of Craig	16.16	5.500	4.343	2.446	1.438	6.048
Town of Rangely	9.00	4.338	3.426	1.929	1.134	4.771
Town of Meeker	16.16	8.007	6.324	3.561	2.094	8.806
Town of Hayden	6.00	1.512	1.194	.673	.395	1.663
Town of Dinosaur	2.56	.749	.592	.333	.196	.824
Total		37.1	29.3	16.5	9.7	40.8

TABLE VI-4

Projected 1990 Emissions from Commercial, Industrial and Residential Fuel Use

External Combustion	Size of Area (sq. km)	Emissions (gm/sec)				
		TSP	SO$_x$	NO$_x$	HC	CO
Area 1	1,350	.928	.730	.412	.242	1.019
Area 2	2,250	1.042	.820	.462	.272	1.144
Area 3	2,225	.043	.034	.019	.011	.047
Area 4	400	.164	.129	.073	.043	.180
Area 5	2,250	.580	.456	.257	.151	.637
Area 6	1,350	.552	.435	.245	.144	.606
Area 7	625	1.750	1.377	.776	.456	1.921
Area 8	500	1.827	1.438	.810	.476	2.006
Area 9	500	.686	.540	.304	.179	.753
Area of Steamboat	15.36	5.123	4.031	2.272	1.335	5.623
City of Steamboat	0.73	2.561	2.015	1.136	.668	2.811
City of Craig	1.13	3.266	2.570	1.449	.851	3.585
Area of Craig	16.16	6.532	5.141	2.898	1.703	7.171
Town of Rangely	9.00	3.939	3.100	1.748	1.027	4.324
Town of Meeker	16.16	8.535	6.716	3.786	2.225	9.369
Town of Hayden	6.00	1.719	1.353	.762	.448	1.887
Town of Dinosaur	2.56	.652	.513	.289	.170	.716
Total		39.9	31.4	17.7	10.4	43.8

Air Quality

TABLE VI-5

Emissions Factors Used to Develop Road
Vehicle Emissions in the Tri-County Area, (gm/km)

Year	TSP		SO_2		NO_2		HC		CO	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
1974	.36	.36	.12	.12	3.2	4.2	4.5	2.7	46.6	23.8
1980	.36	.36	.12	.12	1.9	2.5	1.5	.9	.14	7.0
1985	.36	.36	.12	.12	1.9	2.5	1.5	.9	.14	7.0
1990	.36	.36	.12	.12	1.4	1.8	.99	.60	8.7	4.4

TABLE VI-6

Projected Vehicle Emissions from 1974 Road Travel in the Tri-County Study Area

Road Emissions	Vehicles per day (1974)	Length (km)	Emissions (gm/sec)				
			TSP	SO_x	NO_x	HC	CO
Line Sources							
Link 1	400	30	.050	.017	.583	.375	3.306
Link 2	750	32	.100	.033	1.167	.750	6.611
Link 3	1,950	48	.390	.130	4.550	2.925	25.783
Link 4	1,100	46	.211	.070	2.460	1.581	13.938
Link 5	920	51	.196	.065	2.281	1.466	12.925
Link 6	920	29	.111	.037	1.297	.834	7.349
Link 7	660	24	.066	.022	.770	.495	4.363
Link 8	400	22	.037	.012	.428	.275	2.424
Link 9	400	46	.077	.026	.894	.575	5.069
Link 10	700	35	.102	.034	1.191	.766	6.749
Link 11	900	25	.094	.031	1.094	.703	6.198
Link 12	900	15	.056	.019	.656	.422	3.719
Link 13	550	41	.094	.031	1.096	.705	6.212
Link 14	850	34	.120	.040	1.405	.903	7.961
Area Sources							
Area of Steamboat	2,983	42	.522	.174	4.640	6.525	67.573
Area of Craig	3,334	42	.583	.194	5.186	7.293	75.524
Town of Meeker	1,012	42	.177	.059	1.574	2.214	22.925
Town of Rangely	1,009	42	.177	.059	1.570	2.207	22.857
Town of Dinosaur	173	42	.030	.010	.269	.378	3.919
Town of Hayden	670	42	.117	.039	1.042	1.466	15.177

TABLE VI-7

Projected Vehicle Emissions from 1980 Road Travel in the Tri-County Study Area

Road Emissions	Vehicles per day (1980)	Length (km)	Emissions (gm/sec)				
			TSP	SO_x	NO_x	HC	CO
Line Sources							
Link 1	890	30	.111	.037	.773	.278	2.163
Link 2	1,680	32	.224	.075	1.556	.560	4.356
Link 3	4,360	48	.872	.291	6.056	2.180	16.956
Link 4	2,460	46	.472	.157	3.274	1.179	9.168
Link 5	2,060	51	.438	.146	3.040	1.094	8.512
Link 6	2,060	29	.249	.083	1.729	.622	4.840
Link 7	1,470	24	.147	.049	1.021	.368	2.858
Link 8	890	22	.082	.027	.567	.204	1.586
Link 9	890	46	.171	.057	1.185	.426	3.317
Link 10	1,560	35	.228	.076	1.580	.569	4.424
Link 11	2,010	25	.209	.070	1.454	.523	4.071
Link 12	2,010	15	.126	.042	.872	.314	2.443
Link 13	1,230	41	.210	.070	1.459	.525	4.086
Link 14	1,900	34	.269	.090	1.869	.673	5.234
Area Sources							
Area of Steamboat	5,813	42	1.017	.339	5.369	4.239	39.561
Area of Craig	8,506	42	1.489	.496	7.856	6.202	57.888
Town of Meeker	4,981	42	.872	.291	4.601	3.632	33.898
Town of Rangely	2,759	42	.483	.161	2.548	2.012	18.777
Town of Dinosaur	405	42	.071	.024	.374	.295	2.756
Town of Hayden	1,255	42	.220	.073	1.159	.915	8.541
Seneca - Ruby Haul Road		25	24.10	.089	1.297	.239	1.367

TABLE VI-8

Projected Vehicle Emissions from 1985 Road Travel in the Tri-County Study Area

			Emissions (gm/sec)				
Road Emissions	Vehicles per day (1985)	Length (km)	TSP	SO_x	NO_x	HC	CO
Line Sources							
Link 1	1,050	30	.131	.044	.911	.328	2.552
Link 2	1,960	32	.261	.087	1.815	.653	5.081
Link 3	5,090	48	1.018	.339	7.069	2.545	19.794
Link 4	2,870	46	.550	.183	3.820	1.375	10.696
Link 5	2,400	51	.510	.170	3.542	1.275	9.917
Link 6	2,400	29	.290	.097	2.014	.725	5.639
Link 7	1,720	24	.172	.057	1.194	.430	3.344
Link 8	1,050	22	.096	.032	.668	.241	1.872
Link 9	1,050	46	.201	.067	1.398	.503	3.913
Link 10	1,830	35	.267	.089	1.853	.667	5.189
Link 11	2,350	25	.245	.082	1.700	.612	4.760
Link 12	2,350	15	.147	.049	1.020	.367	2.856
Link 13	1,440	41	.246	.082	1.708	.615	4.783
Link 14	2,220	34	.315	.105	2.184	.786	6.115
Area Sources							
Area of Steamboat	6,766	42	1.184	.395	6.249	4.934	46.046
Area of Craig	7,550	42	1.321	.440	6.973	5.505	51.382
Town of Meeker	7,328	42	1.282	.427	6.768	5.343	49.871
Town of Rangely	3,970	42	.695	.232	3.667	2.895	27.018
Town of Dinosaur	686	42	.120	.040	.634	.500	4.669
Town of Hayden	2,142	42	.375	.125	1.978	1.562	14.578
Seneca - Ruby Haul Road		25	24.100	.089	1.297	.239	1.367

TABLE VI-9

Projected Vehicle Emissions from 1990 Road Travel in the Tri-County Study Area

Road Emissions	Vehicles per day (1990)	Length (km)	Emissions (gm/sec)				
			TSP	SO_x	NO_x	HC	CO
Line Sources							
Link 1	1,120	30	.140	.047	.700	.233	1.711
Link 2	2,110	32	.281	.094	1.407	.469	3.439
Link 3	5,480	48	1.096	.365	5.480	1.827	13.396
Link 4	3,090	46	.592	.197	2.961	.987	7.239
Link 5	2,580	51	.548	.183	2.741	.914	6.701
Link 6	2,580	29	.312	.104	1.559	.520	3.810
Link 7	1.850	24	.185	.062	.925	.308	2.261
Link 8	1,120	22	.103	.034	.513	.171	1.255
Link 9	1,120	46	.215	.072	1.073	.358	2.624
Link 10	1,970	35	.287	.096	1.436	.479	3.511
Link 11	2,530	25	.264	.088	1.318	.439	3.221
Link 12	2,530	15	.158	.053	.791	.264	1.933
Link 13	1,540	41	.263	.088	1.315	.438	3.215
Link 14	2,390	34	.339	.113	1.693	.564	4.138
Area Sources							
Area of Steamboat	7,028	42	1.230	.410	4.783	3.382	29.723
Area of Craig	8,962	42	1.568	.523	6.099	4.313	37.902
Town of Meeker	7,806	42	1.366	.455	5.312	3.757	33.013
Town of Rangely	3,603	42	.631	.210	2.452	1.734	15.238
Town of Dinosaur	596	42	.104	.035	.406	.287	2.521
Town of Hayden	2,239	42	.392	.131	1.524	1.078	9.469
Seneca - Ruby Haul Road		25	24.100	.089	1.297	.239	1.367

TABLE VI-10

Projected Emissions from Railroads in the Tri-County Region (gm/sec)

Railroad	Number of Trains/Day	TSP	SO_x	NO_x	HC	CO
D & RGW R.R.						
1974	3	.23	0.5	3.2	0.8	1.1
1980	13	1.0	3.1	13.8	3.5	4.9
W.R. Grace R.R.						
1980	1	.02	0.06	0.4	0.1	0.1

TABLE VI-11

Quantity of Material That Would Be Handled (metric tons per year*) At Each Coal Mine Included in the Regional Impact Statement

Mines	Present Coal Production	Present Over-burden	Present Topsoil	1980 Coal Production	1980 Over-burden	1980 Topsoil
W. R. Grace	0	0	0	2.72	24.38	.32
Seneca 2-W	0	0	0	.82	6.45	.13
Energy 1	1.13	17.98	.16	2.25	35.96	.43
Energy 2	.52	4.67	.07	1.11	9.93	.41
Energy 3	0	0	0	1.18	16.03	.35
Utah International	0	0	0	2.61	47.54	.41
Edna	.09	9.56	.13	1.00	10.52	.14
Seneca 2	.54	5.74	.08	.54	5.74	.08
Empire Energy	.27	2.87	.04	.27	2.87	.04
Paul Coupey	0	0	0	.91	9.56	.13
Moonlake	0	0	0	1.36	14.34	.19
Routt Mining	0	0	0	.18	1.91	.03
Ruby (U)	0	-	-	.18	--	--
Apex (U)	.01	-	-	.03	--	--
Reinau (U)	.01	-	-	.27	--	--
Coal Fuels (U)	0	-	-	1.82	--	--
Aggregate for Merchants, Woodward and Consolidated Coal	0	0	0	3.81	38.24	.51

* 1 metric ton = 1.1016 short tons.

U Indicates underground mining.

TABLE VI-11 (Cont.)

Quantity of Material That Would Be Handled (metric tons per year*)
At Each Coal Mine Included in the Regional Impact Statement

Mines	1985 Coal Production	1985 Over-burden	1985 Topsoil	1990 Coal Production	1990 Over-burden	1990 Topsoil
W. R. Grace	2.72	24.38	.32	2.72	24.38	.32
Seneca 2-W	.82	6.45	.13	.82	6.45	.13
Energy 1	2.25	35.96	.43	2.25	35.96	.43
Energy 2	1.11	9.93	.41	1.11	9.93	.41
Energy 3	1.18	16.03	.35	1.18	16.03	.35
Utah International	2.61	47.54	.41	2.61	47.54	.41
Edna	1.04	10.99	.15	.36	3.82	.05
Seneca	.54	5.74	.08	.54	5.74	.08
Empire Energy	.27	2.87	.04	.36	3.82	.05
Paul Coupey	.91	9.56	.13	.91	9.56	.13
Moonlake	2.09	21.99	.29	3.36	35.37	.47
Routt Mining	.27	2.87	.04	.27	2.87	.04
Ruby (U)	.18	--	--	.18	--	--
Apex (U)	.04	--	--	.04	--	--
Reinau (U)	.27	--	--	.36	--	--
Coal Fuels (U)	1.82	--	--	1.82	--	--
Aggregate for Merchants, Woodward and Consolidation Coal	3.81	38.24	.51	3.81	38.24	.51

* 1 metric ton = 1.1016 short tons.

U Indicates underground mining.

TABLE VI-12

Projected Suspended Particulate Emissions from Materials Handling

Mine	Emissions (gm/sec)				Emission Per Unit Area (gm/m^2 sec)
	Present	1980	1985	1990	
W. R. Grace	0	20.54	20.54	20.54	3.76×10^{-5}
Seneca 2W	0	5.54	5.54	5.54	2.49×10^{-5}
Energy 1	14.43	28.94	28.94	28.94	3.95×10^{-5}
Energy 2	3.95	8.58	8.58	8.58	1.23×10^{-5}
Energy 3	0	13.16	13.16	13.16	2.18×10^{-5}
Utah International	0	37.89	37.89	37.89	5.38×10^{-5}
Edna	7.94	8.73	9.13	3.18	3.64×10^{-5}
Seneca 2	4.76	4.76	4.76	4.76	2.87×10^{-5}
Empire Energy	2.38	2.38	2.38	3.18	2.91×10^{-5}
Paul Coupey	0	7.94	7.94	7.94	2.89×10^{-5}
Moonlake	0	11.91	18.26	29.37	3.63×10^{-5}
Routt Mining	0	1.59	2.38	2.38	2.94×10^{-5}
Ruby (U)	0	.14	.14	.14	1.73×10^{-5}
Apex (U)	.01	.02	.03	.03	$.74 \times 10^{-5}$
Reinau (U)	.01	.21	.21	.29	2.55×10^{-5}
Coal Fuels (U)	0	1.44	1.44	1.44	4.24×10^{-5}
Total	33.48	185.77	193.32	199.27	
Aggregate for Merchants, Woodward and Consolidation Coal	0	31.89	31.89	31.89	6.00×10^{-5}

U Indicates underground mining.

TABLE VI-13

Within Mine Vehicle Emissions (metric tons/year)

Mines	Number of Gasoline Powered Vehicles	Haul Truck Capability (metric tons)	Haulage Trips Per Day	TSP		SO$_x$		NO$_x$		HC		CO	
				Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks
W. R. Grace	244	91	82	.121	.089	.029	.180	1.140	2.514	1.461	.251	7.837	1.520
Seneca 2-W	44	23	98	.022	.106	.005	.215	.206	3.005	.263	.300	1.413	1.817
Energy 1	294	23	268	.146	.290	.035	.587	1.374	8.217	1.760	.822	9.443	4.969
Energy 2	145	23	132	.072	.143	.017	.289	.677	4.047	.868	.405	4.657	2.448
Energy 3	154	23	141	.076	.152	.018	.309	.719	4.323	.922	.432	4.946	2.614
Utah International	190	68	105	.094	.113	.022	.230	.888	3.219	1.137	.322	6.103	1.947
Edna	75	23	119	.037	.129	.009	.261	.350	3.649	.449	.365	2.409	2.206
Seneca 2	50	23	64	.025	.069	.006	.140	.234	1.962	.299	.196	1.606	1.187
Empire Energy	30	23	32	.015	.035	.004	.070	.140	.981	.180	.098	.964	.593
Paul Coupey	80	23	108	.040	.117	.009	.237	.374	3.311	.479	.331	2.570	2.002
Moonlake	746	91	41	.370	.044	.088	.090	3.485	1.257	4.466	.126	23.962	.760
Other Mines	530	23-91	120	.263	.141	.063	.285	2.476	3.986	3.173	.398	17.024	2.410
Total				1.281	1.428	.305	2.893	12.063	40.471	15.457	4.046	82.934	24.473

* 1 metric ton = 1.1016 short tons.

Site Specific Emissions

Introduction

Potential emissions of air pollutants from the various sources at each mine are calculated using a uniform methodology. First an emission factor for each pollutant from each source is developed from referenced studies and altered as necessary to best apply to individual mine characteristics. The term "emission factor" means the quantity of air pollutant generated by a source per unit of source operation. The unit of quality used is mass of pollutant. Source operation units include vehicle miles, mass of material handled and mass of coal produced.

Potential emissions have been categorized in terms of: (1) fugitive dusts from the mining operation, including material handling and storage, (2) fugitive dust from use of off-mine roads, and (3) fugitive dusts from processing, including material transport, and crushing or grinding, and (4) vehicle exhaust. Emission factors are applied to individual sources by simply multiplying the source operation rate by the appropriate emission factor (and any other factor designed to take special conditions into account). All emissions have been calculated on an annual basis to allow for smoothing of day-to-day fluctuations. Emissions are thus given in terms of mass/year.

To indicate the exact formulas of calculation, Table VI-14 has been prepared. All equations used to compute emissions have been included. Parameters, symbols, units, and numerical values are specified in Table VI-15. Subsequent text describes in detail the derivations, calculations, and approximations used for each source.

Air Quality

TABLE VI-14

Formulas for Calculating Emissions

Constants are conversion factors

Fugitive Dust - Off-Mine Roads

$$E_1 = CMF_1 \left(\frac{D_1 P}{A_1} + ND_2\, U\right) (10^{-3})$$

Vehicle Emissions - Within Mine

Trucks

$$E_3 = \frac{PD_3}{A_2} F_3 \; (10^{-6})$$

$$E_5 = \frac{PD_3}{A_2} F_5 \; (10^{-6})$$

$$E_7 = \frac{PD_3}{A_2} F_7 \; (10^{-6})$$

$$E_9 = \frac{PD_3}{A_2} F_9 \; (10^{-6})$$

$$E_{11} = \frac{PD_3}{A_2} F_{11} \; (10^{-6})$$

Cars

$$E_4 = ND_4 UF_4 \; (10^{-6})$$

$$E_6 = ND_4 UF_6 \; (10^{-6})$$

$$E_8 = ND_4 UF_8 \; (10^{-6})$$

$$E_{10} = ND_4 UF_{10} \; (10^{-6})$$

$$E_{12} = ND_4 UF_{12} \; (10^{-6})$$

Fugitive Dust - Mining

$$E_{13} = CTL_1 S_1 \; F_{13}$$

$$E_{14} = CTL_2 S_2 \; F_{14}$$

$$E_{15} = CTL_3 S_3 \; F_{15}$$

Vehicle Emissions - Off-Mine

Trucks

$$E_{17} = \frac{PD_1}{A_1} F_3 \; (10^{-6})$$

$$E_{19} = \frac{PD_1}{A_1} F_5 \; (10^{-6})$$

$$E_{21} = \frac{PD_1}{A_1} F_7 \; (10^{-6})$$

$$E_{23} = \frac{PD_1}{A_1} F_9 \; (10^{-6})$$

$$E_{25} = \frac{PD_1}{A_1} F_{11} \; (10^{-6})$$

Cars

$$E_{18} = ND_2 UF_4 \; (10^{-6})$$

$$E_{20} = ND_2 UF_6 \; (10^{-6})$$

$$E_{22} = ND_2 UF_8 \; (10^{-6})$$

$$E_{24} = ND_2 UF_{10} \; (10^{-6})$$

$$E_{26} = ND_2 UF_{12} \; (10^{-6})$$

Process

$$E_{16} = P \; F_{16} \; (10^{-3})$$

TABLE VI-15

Definitions and Numerical Values of Emission Calculation Parameters

Definition	Symbol	Units	Numerical Value for Site Specifics						Source
					Energy Fuels				
			Grace/Colowyo	Seneca 2W	1	2	3	Ruby	
Coal Production Rate	P	metric tons/yr x 10^6	2.7	0.82	2.2	1.1	1.2	0.18	Mine Plans
Number of Employees	N	---	244	43	294	145	154	45	Mine Plans
Area of Distrubed Land	T	km^2/year	0.55	0.22	0.73	0.70	0.60	NA	Mine Plans
Average Depth of Topsoil	L_1	meters	0.30	0.30	0.30	0.30	0.30	NA	Mine Plans
Average Depth of Overburden	L_2	meters	21	14	23	6.8	13	NA	Mine Plans
Average Coal Seam Thickness	L_3	meters	3.7	2.9	2.3	1.2	1.5	NA	Mine Plans
Average Stripping Ratio	R	cu yd/ton	5.1	4.5	9.1	5.1	7.8	NA	Mine Plans
Density of Topsoil	S_1	kg/m_3	1400	1400	1400	1400	1400	NA	Mine Plans
Density of Overburden	S_2	kg/m_3	2000	2000	2000	2000	2000	NA	Mine Plans
Density of Coal	S_3	kg/m_3	1300	1300	1300	1300	1300	NA	Mine Plans
Haulage Truck Capacity, off-mine	A_1	metric tons	23	23	NA	NA	NA	23	Mine Plans
Haulage Truck Capacity, within mine	A_2	metric tons	91	23	23	23	23	23	Mine Plans
Fraction of Dry, Snowless Days	C	---	0.44	0.43	0.43	0.43	0.43	0.51	Table 1
Number of Days in Year Worked	U	days	250	250	250	250	250	250	Mine Plans
Round-Trip Haulage Distances									
Off-mine, trucks	D_1	km	50	39	0	0	0	50	Mine Plans
Off-mine, cars	D_2	km	50	33	50	50	50	50	Mine Plans
Within mine, trucks	D_3	km	3	4	6	4	2	0	Mine Plans
Within mine, cars	D_4	km	4	4	6	4	2	0	Mine Plans
Fraction of Off-Mine Road Unpaved	M	---	0	0.3	0.3	0.3	0.3	1	Mine Plans
Road Fugitive Dust Emission Factor	F_1	kg/km	1	1	1	1	1	1	(PEDCo, 1973)

---

* 1 metric ton = 1.1016 short ton
NA Not applicable

Air Quality

TABLE VI-15 (Cont.)

Definitions and Numerical Values of Emission Calculation Parameters

Definition	Symbol	Units	Numerical Value for Site Specifics						Source
			Grace/Colowyo	Seneca 2W	Energy Fuels 1	Energy Fuels 2	Energy Fuels 3	Ruby	
OFF-MINE									
Vehicle Exhaust Emission Rates									
Nitrogen Oxides, trucks	E_{23}	metric tons/year	120.	28.	0	0	0	10.	Calculated
Nitrogen Oxides, cars	E_{24}	metric tons/year	9.7	1.1	11.8	5.8	6.2	1.8	Calculated
Sulfur Oxides, trucks	E_{25}	metric tons/year	8.7	2.0	0	0	0	0.75	Calculated
Sulfur Oxides, cars	E_{26}	metric tons/year	0.24	0.029	0.30	0.15	0.16	0.045	Calculated
WITHIN MINE									
Fugitive Dust Uncontrolled Emission Rate, Topsoil	E_{13}	metric tons/year	5.6	2.2	6.4	7.0	6.0	NA	Calculated
Overburden	E_{14}	metric tons/year	560.	150.	800.	220.	370.	NA	Calculated
Coal	E_{15}	metric tons/year	64.	20.	51.	26.	28.	NA	Calculated
Vehicle Exhaust Emission Rates									
Particulates, trucks	E_3	metric tons/year	0.066	0.11	0.42	0.14	0.077	0	Calculated
Particulates, cars	E_4	metric tons/year	0.033	0.015	0.15	0.049	0.026	0	Calculated
Hydrocarbons, trucks	E_5	metric tons/year	0.19	0.31	1.2	0.40	0.22	0	Calculated
Hydrocarbons, cars	E_6	metric tons/year	1.0	0.13	1.3	0.58	0.32	0	Calculated
Carbon Monoxide, trucks	E_7	metric tons/year	4.5	0.48	7.2	2.4	1.3	0	Calculated
Carbon Monoxide, cars	E_8	metric tons/year	5.4	0.97	9.8	3.2	1.71	0	Calculated
Nitrogen Oxides, trucks	E_9	metric tons/year	1.9	3.1	12.	4.0	2.2	0	Calculated
Nitrogen Oxides, cars	E_{10}	metric tons/year	0.77	0.14	1.4	0.45	0.24	0	Calculated
Sulfur Oxides, trucks	E_{11}	metric tons/year	0.13	0.22	0.85	0.23	0.16	0	Calculated
Sulfur Oxides, cars	E_{12}	metric tons/year	0.020	0.0036	0.037	0.012	0.0062	0	Calculated
Process Particulate Emission Rate, Controlled	E_{16}	metric tons/year	68.	NA	55.	28.	20.	4.5	Calculated

TABLE VI-15 (Cont.)

Definitions and Numerical Values of Emission Calculation Parameters

Definition	Symbol	Units	Numerical Value for Site Specifics						Source
			Grace/Colowyo	Seneca 2W	Energy Fuels 1	Energy Fuels 2	Energy Fuels 3	Ruby	
Vehicle Exhaust Emission Factors									
Particulates, trucks	F_3	gm/km	0.74	0.74	0.74	0.74	0.74	0.74	EPA, 1973
Particulates, cars	F_4	gm/km	0.34	0.34	0.34	0.34	0.34	0.34	EPA, 1973
Hydrocarbons, trucks	F_5	gm/km	2.1	2.1	2.1	2.1	2.1	2.1	EPA, 1973
Hydrocarbons, cars	F_6	gm/km	4.1	4.1	4.1	4.1	4.1	4.1	EPA, 1973
Carbon Monoxide, trucks	F7	gm/km	12.7	12.7	12.7	12.7	12.7	12.7	EPA, 1973
Carbon Monoxide, cars	F8	gm/km	22.	22.	22.	22.	22.	22.	EPA, 1973
Nitrogen Oxides, trucks	F_9	gm/km	21.	21.	21.	21.	21.	21.	EPA, 1973
Nitrogen Oxides, cars	F_{10}	gm/km	3.2	3.2	3.2	3.2	3.2	3.2	EPA, 1973
Sulfur Oxides, trucks	F_{11}	gm/km	1.5	1.5	1.5	1.5	1.5	1.5	EPA, 1973
Sulfur Oxides, cars	F12	gm/km	0.081	0.081	0.081	0.081	0.081	0.081	EPA, 1973
Fugitive Dust Emission Factor,									
Topsoil	F13	kg/metric ton	0.055	0.055	0.055	0.055	0.055	0.055	Cowherd, 1974
Overburden	F_{14}	kg/metric ton	0.055	0.055	0.055	0.055	0.055	0.055	Cowherd, 1974
Coal	F_{15}	kg/metric ton	0.055	0.055	0.055	0.055	0.055	0.055	Cowherd, 1974
Process Particulate Emission Factor	F_{16}	kg/metric ton	0.025	0.025	0.025	0.025	0.025	0.025	EPA, 1973
OFF-MINE									
Fugitive Dust Emission Rate, Roads	E_1	metric tons/year	0	220	490	240	260	540	Calculated
Vehicle Exhaust Emission Rates									
Particulates, trucks	E_{17}	metric tons/year	4.3	1.0	0	0	0	0.37	Calculated
Particulates, cars	E_{18}	metric tons/year	1.0	0.12	1.2	.62	.65	0.19	Calculated
Hydrocarbons, trucks	E_{19}	metric tons/year	12.	2.8	0	0	0	1.0	Calculated
Hydrocarbons, cars	E_{20}	metric tons/year	12.	1.4	15.	7.4	7.9	2.3	Calculated
Carbon Monoxide, trucks	E_{21}	metric tons/year	74.	17.	0	0	0	6.3	Calculated
Carbon Monoxide, cars	E_{22}	metric tons/year	66.	7.8	80.	40.	42.	12.	Calculated

Fugitive dust

Potential fugitive dust emissions from the mining activities of handling topsoil, overburden, and coal have been calculated separately, but consistently. Emissions factors for topsoil dust, F_{13}, overburden dust, F_{14}, and coal dust, F_{15}, were obtained by applying the work of Cowherd (1974) to the mining of coal. In that study, emission factors for mass of particulates that will become and remain airborne per mass of handled material were obtained by measurements of emissions from the removal and storage of aggregate. Particles greater than 30 micrometers in diameter were assumed to settle out of the atmosphere in short distances and were not considered. Since the material moved at the mine would not be aggregate, but coarse broken rock containing few fine particles, emission factors were reduced by a factor of three, over those recommended by EPA (1973) to describe the effects of crushing on aggregate. Emission factors developed by the methodology of Cowherd (1974) include a breakdown of 12 percent contribution from storage pile formation, 40 percent from vehicular traffic, 33 percent from wind erosion, and 15 percent from redistribution or loading of material.

Potential uncontrolled emissions were calculated from the emission factors and the mass of the material that would be moved at the mine. For topsoil, overburden, and coal, the mass is calculated in the formulas and is given by the product of the density (S), the thickness of the material in the ground (L), and the total area disturbed (T). Values for these parameters were obtained from mine plans or were estimated. The production rate of coal (P) was used to check the consistency of the calculated mass of coal that would be removed. In the same manner the stripping ratio (R) relates the overburden quantity to the coal produced. All topsoil was considered to be a foot (0.3 meter) in thickness.

The EPA/Cowherd estimates of emission factors required correction for local climatic conditions. Fugitive dust is generated by traffic and wind erosion mainly on dry days; moving of material into storage areas can be dusty even on wet days because of exposure of subsurface dry material. It is estimated that approximately half the fugitive dust is emitted from a given area on wet or frozen days compared with dry conditions.

In order to account for rain, snow, and frozen ground, and the differing character of the materials handling processes, a climatic factor, C, was developed and applied to the uncorrected emission factor. C is the net effect of climate on fugitive dust emissions, i.e., C is the fraction of dry days times the fraction of dust generated by vehicular traffic and wind erosion, plus the sum of the fraction of dry days and half of the fraction of wet days, times the fraction of dust generated by forming and redistributing storage piles. As an example, consider the Colowyo mine site where 65 percent of the days in a year are wet, frozen or covered with snow, and 35 percent are dry. Then the climatic factor is:

$$C = (0.35\ (0.40 + 0.33) + (0.35 + \qquad)\ (0.12 + 0.15)$$

$$= 0.44.$$

Using the local climatic descriptions, the fraction of the time that the surface is wet or frozen was estimated. It is expected that many material surfaces will be moistened with water to limit dust generation. Although the efficiency of water application as a control measure is difficult to assess because of varying soil conditions, a value of

50 percent of the uncontrolled emissions (corrected by climate) is used here (PEDCo, 1973). This is applied only to the emissions from traffic during "dry" days; watering would be expected to reduce uncontrolled emissions by about ten percent.

Uncertainties (two standard deviations) of fugitive dust emission estimates are on the order of a factor of two, as described in Cowherd (1974), and based on considerations of the variations in material characteristics.

Fugitive dust - off-mine roads

Unpaved roads potentially are a large source of fugitive dust from vehicular traffic. Roads within the mine site have been included in the mining fugitive dust calculations. Away from the mine property, vehicles traveling on unpaved roads because of the mine must be considered. An equation is included in Table VI-14 to calculate fugitive dust emissions from roads. It includes a sum of two terms, representing total potential miles traveled/year by coal haulage trucks, and total potential miles of cars of employees, times the climatic factor (C), the emission factor for roads (F_1), and a correction factor (M), for the fraction of the total roads traveled that are unpaved.

Fugitive dust emissions from unpaved roads were studied by PEDCo (1973) in an arid climate. The average emission factor obtained was about one kilogram of suspended particulate/vehicle-kilometer.

Total truck mileage for the haulage of coal was calculated from the tons of coal produced (P), the capacity of the trucks (A_1), and the distance of a round trip (D_1). One round trip to the nearest town on paved road was assumed for each of the employees at the mine (total number (N), over a distance (D_2), for the number of working days/year (U). Because of the assumptions necessary and the limited studies performed on unpaved roads, an uncertainty of at least a factor of two must be considered for road fugitive dust emissions.

In the PEDCo report text, watering of the roads has been considered to be a control measure with an efficiency of about 50 percent. This efficiency differs from that assumed for mine control because experience has indicated that hard-packed established roads are better controlled by watering than new mine trades and storage piles.

Process emissions

Process emissions of suspended particulates involve two types. Half of the emissions are assumed to result as fugitive dust, and half as particulates that are 99 percent collected in control devices. The "controlled" emissions are thus one percent of one-half the "uncontrolled". This distinction is made to indicate the difference between generation of dust and emission of suspended particulate.

Fugitive dust is generated by material transport, spilling, transfers between conveyors, and mechanical operations of crushing and sorting. Process emissions also include fine particulate matter emitted directly to the atmosphere from control device exhausts. Dust that is captured by a collection system, such as a hood over a crusher, can be retained by a control device (e.g., a baghouse) with efficiencies of 99 percent or better. The uncaptured portions from conveyors, transfer points and spillage are emitted directly to the atmosphere. As a means of estimating potential total generation of particulates, essentially all as coal dust, an emission factor of 0.44 kilograms of dust/metric ton of coal has been applied. This was obtained by interpolating between emission factors given for several different crushing operations in EPA (1973). The equation for process particulate emissions is simply the coal production rate times the emission factor.

Vehicle exhaust

Suspended particulates, and four gaseous pollutants: carbon monoxide, nitrogen oxides, hydrocarbons, and sulfur oxides, are emitted from vehicles. Emission factors for internal combustion engines, both diesel and gasoline, have been obtained from EPA (1973). At the mine, there would be vehicle exhaust emissions from heavy diesel mine equipment, haulage trucks, and gasoline powered cars and trucks. Emissions of each pollutant from haulage trucks (E_3 to E_{11}, odd subscripts) were calculated by multiplying the total yearly truck miles that would be used moving coal to the mine processing facilities, by the appropriate emission factor. Truck miles are equal to the amount of coal hauled/year (P), times the haulage round-trip distance within mine (D_3), divided by the capacity of the trucks (A_2).

Potential automobile emissions (E_4 to E_{12}, even subscripts) were based on two trips/day over a course through the mine for U days a year. The distance traveled (D_4) was doubled to take into account two round trips.

In addition to vehicle travel within the mine, coal haulage and automobile travel off-mine were considered. Calculations are similar to those described above for fugitive dust from off-mine roads.

Vehicle exhaust emission factors are based on a much wider history of measurements than fugitive dust emission factors, thus have lower uncertainties. However due to the approximations in the traffic patterns, a factor of two uncertainty is again realistic.

Modeling Techniques

The Environmental Research & Technology Air Quality (ERTAQ) Model was used to develop the expected impacts of the regulated pollutants from site specific mines. Several model options were used in developing 24-hour and annual pollutant concentrations. A general description of ERTAQ is provided before discussing its specific use and input requirements as it was applied in this study.

Model description

The ERTAQ model is a regional model which allows the examination of multiple sources as well as multiple meteorological conditions. The model can average concentrations due to many sources over longer time periods -- e.g., a season, or a year. It does not take into account such effects as changes in terrain on effluent dispersion, and it is able to calculate pollutant concentrations at only 100 preselected receptor sites.

The fundamental equation used in ERTAQ is the Gaussian plume equation which estimates ground-level pollutant concentrations by the methodology presented in the Workbook of Atmospheric Diffusion Estimates (Turner, 1972). The general form of the equation for the coordinate system presented in Appendix D is:

$$\chi(0,0,z) = \frac{q(x,-y,H)}{2\pi\sigma_y\sigma_z u} \exp\left[-1/2 \left(\frac{y}{\sigma_y}\right)^2\right] \Bigg\{ \cdot \exp\left[-1/2 \left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-1/2 \left(\frac{z+H}{\sigma_z}\right)^2\right]\Bigg\} \cdot \left[e^{-t/\lambda}\right] \qquad \text{EQUATION 1}$$

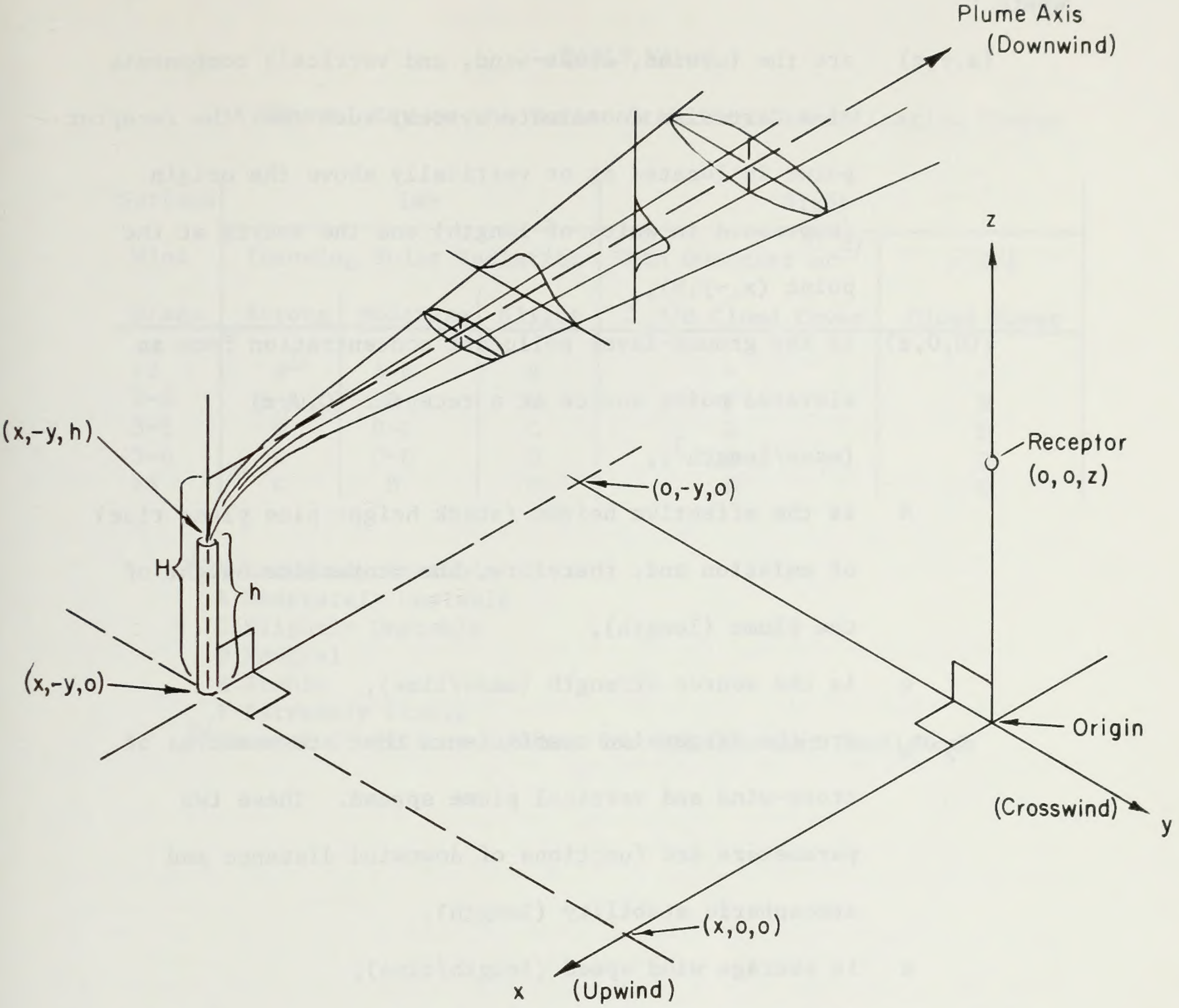


FIGURE VI-3

Coordinate system showing Gaussian distributions in the crosswind and vertical directions.

where

(x,y,z) are the (upwind, cross-wind, and vertical) components of a Cartesian coordinate system, such that the receptor point is located at or vertically above the origin (expressed in units of length) and the source at the point $(x,-y,H)$,

$\chi(0,0,z)$ is the ground-level pollutant concentration from an elevated point source at a receptor $(0,0,z)$ (mass/length^3),

H is the effective height (stack height plus plume rise) of emission and, therefore, the centerline height of the plume (length),

q is the source strength (mass/time),

σ_y, σ_z are the dispersion coefficients that are measures of cross-wind and vertical plume spread. These two parameters are functions of downwind distance and atmospheric stability (length),

u is average wind speed (length/time),

λ is a decay rate for pollutant in the atmosphere (time),

and t is the travel time from source to receptor and equals x/u (time).

Calculations performed with the ERTAQ model involve multiple applications and spatially-integrated forms of the Gaussian plume equation. The resulting concentrations are those expected during five stability categories. These categories are those specified by Turner except that ERTAQ Stability 5 is a condensation of Turner Stabilities E and F (Table VI-16).

TABLE VI-16

A General Key to the Turner Stability Classification System

Surface	Day			Night	
Wind	Incoming Solar Radiation			Thin Overcast or[2]	> 4/8
m/sec	Strong	Moderate	Slight	≤ 3/8 Cloud Cover	Cloud Cover
<2	A[1]	A-B	B	-	-
2-3	A-B	B	C	F	E
3-5	B	B-C	C	E	D
5-6	C	C-D	D	D	D
>6	C	D	D	D	D

[1] A Extremely Unstable
B Moderately Unstable
C Slightly Unstable
D Neutral
E Stable
F Extremely Stable

[2] Neutral Conditions Assumed for all Overcast Conditions

ERTAQ considers six wind speed categories, represented by the following speeds: .72, 2.57, 4.38, 6.95, 9.78, and 13.1 mps, which are identical for each stability class. The combination of five stability classes, six wind speed classes, and sixteen wind directions give a total of 480 weather conditions considered in the ERTAQ model.

The calculation of short-term concentrations -- sector averaging

Hourly ground-level concentration estimates can be obtained directly from Equation 1 by setting z = 0. However, since the contribution of both area and point sources are calculated, a modified version of the equation is used.

Although the probability of all wind directions is continuous function over long time periods, for model computation purposes discrete wind directions are specified with respect to a 16-point compass, corresponding to 22.5° angular sectors. Over long periods it is often assumed that all wind directions within a given 22.5° sector occur with equal frequency; thus the effluent could be assumed to be uniformly distributed in the horizontal within the sector. However, this assumption would result in discontinuities in calculated concentrations at sector boundaries when considering several sources. A more reasonable distribution is obtained by using a linear interpolation between sector centerlines. In this case, the concentration at a given receptor location is composed of proportional contributions from both the sector containing the receptor and from the nearest adjacent sector. The linear interpolation term is given by:

$$\frac{K(c - |y|)}{c}$$

where

y = cross-wind distance between the receptor and the sector centerline (m),

c = sector width at the receptor locations = 2 x tan (11.25°)
= 0.398 x (m),

K = a constant to be determined.

The geometry of the interpolation is illustrated in Figure VI-4. Note that a south-southwest wind affects the receptor north-northeast of the source.

The linear interpolation is applied to the crosswind integrated form of the ground-level plume equation, and the constant K is determined as follows:

$$K = \sqrt{2\pi}\,\frac{\sigma_y}{c} \quad ,$$

and the equation used in the hourly computations becomes

$$\chi = \frac{\sqrt{2}\,q}{\sqrt{\pi}\sigma_z u}\left(\frac{c - |y|}{c^2}\right) \exp\left[-1/2\left(\frac{H}{\sigma_z}\right)^2\right]\left[e^{-+/\lambda}\right] \qquad \text{EQUATION 2}$$

Hourly concentrations can be calculated from the above equation by specifying the appropriate dispersion parameter (σ_z).*

The values of the dispersion parameters σ_z used in ERTAQ to simulate the dispersion of emissions from area sources were those from Calder (1971) as expressed in the functional form:

$$\sigma_z = ax^b + c$$

The coefficients a and c and the exponent b are specified by downwind distance as shown in Table VI-17.

---

*σ_y is not considered in the linear interpolation scheme.

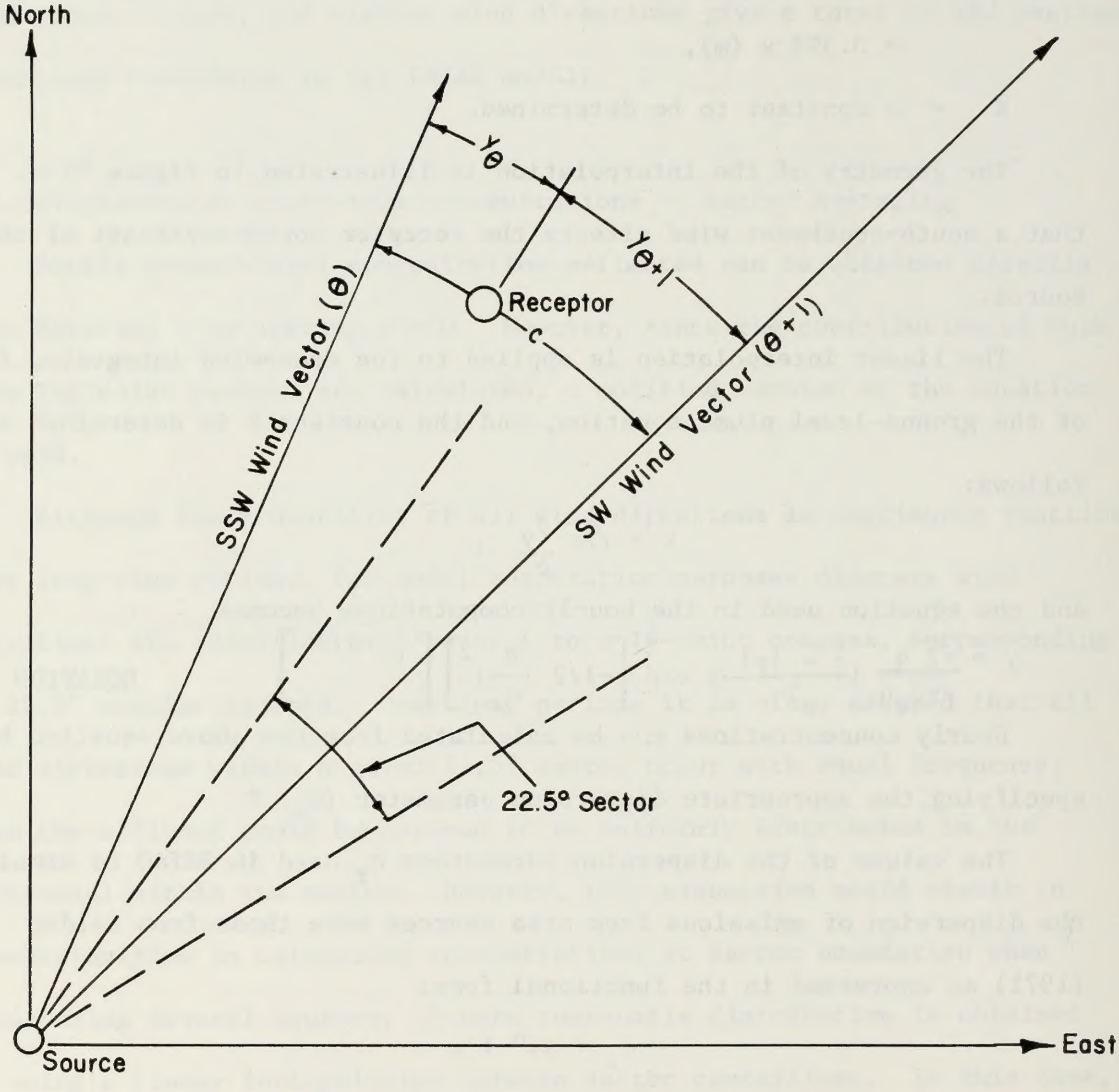


FIGURE VI-4

Geometry of the linear interpolation between adjacent wind direction sectors.

TABLE VI-17

Dispersion Parameters Used in Calculating
Vertical Dispersion Plume From Area Sources

Stability Class	x < 100 m			100 m <x <1000 m			x < 1000 m		
	a	b	c	a	b	c	a	b	c
1 Extremely Unstable	0.174	0.936	0.0	0.001	1.89	9.6	0.001	1.89	9.6
2 Moderately Unstable	0.143	0.922	0.0	0.048	1.11	2.0	0.048	1.11	2.0
3 Slightly Unstable	0.123	0.905	0.0	0.119	0.915	0.0	0.119	0.915	0.0
4 Neutral	0.080	0.881	0.0	0.187	0.775	-1.4	2.61	0.450	-25.5
5 Stable	0.060	0.845	0.0	0.135	0.745	-1.1	52.6	0.150	-126.0

The term q in Equation 2 represents emissions from the aggregate of background pollutant emissions. To simulate concentrations due to area source emissions, the Gaussian plume equation is modified as follows. Each area source is divided into a number of rectangular elements; the contribution of each element of area is summed in the integration over area:

$$\chi(o,o,z) = \int_{x} dx \int_{y} dy \frac{Q_A(x,y,H)}{2\pi \, \sigma_y \sigma_z \, u} \exp\left[-1/2 \left(\frac{Y}{\sigma_y}\right)^2\right]$$

EQUATION 3

$$\cdot \left[\exp \; -1/2 \left(\frac{z-H}{z}\right)^2 + \exp\left[-1/2 \left(\frac{z+H}{z}\right)^2\right]\right]\left[e^{-t/\lambda}\right] .$$

A rectangular area source was assumed with a uniform distribution Q_A. The geometry applicable to this discussion is given in Figure VI-5. Equation B-4 becomes:

$$\chi = Q_A \int_{x_1}^{x_2} dx \frac{1}{2\pi \, \sigma_y \sigma_z \, u} F_z(a,H,x) \int_{y_{min}}^{y_{max}} dy \left[\exp \; -1/2 \left(\frac{y}{\sigma_y}\right)^2\right]\left[e^{-t/\lambda}\right]$$

where

EQUATION 4

$$F_z \; (a,H,x) = \exp\left[-1/2 \left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-1/2 \left(\frac{z+H}{\sigma_z}\right)^2\right]$$

where y_{max} and y_{min} are functions of the integration variable X. Computer realization of Equation 4 is achieved by a summation of elemental strips between the limits x_1 and x_2. An innovative aspect of the ERTAQ treatment of area source emissions is the orientation of the elemental strips

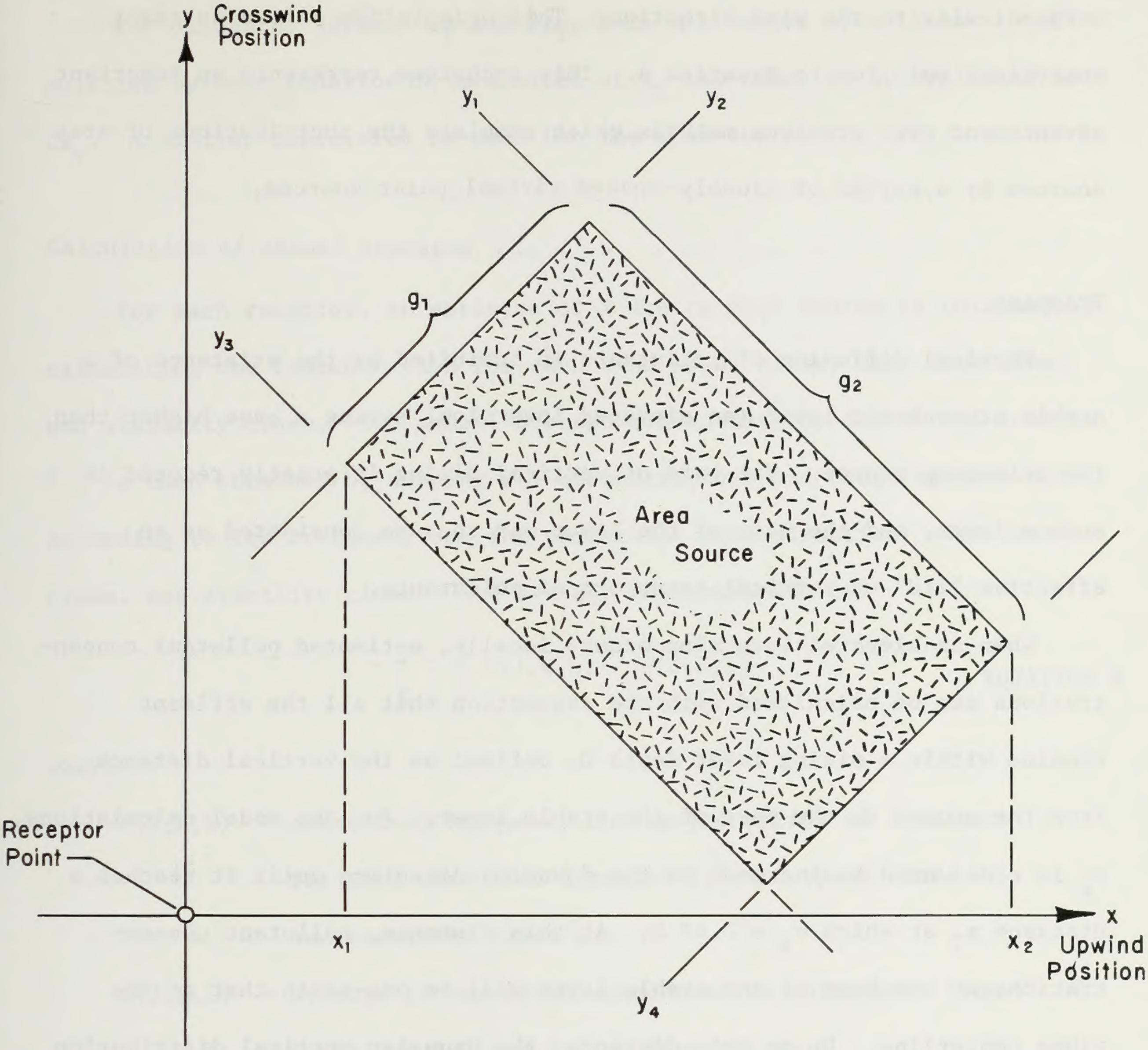


FIGURE VI-5

Geometry for area source with dimensions g_1 and g_2 in the horizontal plane; shown in the receptor-centered, wind oriented, coordinate system.

perpendicular to the wind direction. This orientation allows an exact analytical solution to Equation 4. This technique represents an important advancement over previous methods which simulate the contributions of area sources by a series of closely-spaced virtual point sources.

Trapping

Vertical diffusion of pollutants is inhibited by the existence of a stable atmospheric layer (an elevated inversion) having a base higher than the emissions source. The rate of vertical mixing is greatly reduced in such a layer, and the base of the layer can thus be considered as an effective "lid" on vertical transport of pollutants.

When an elevated inversion occurs locally, estimated pollutant concentrations can be calculated with the assumption that all the effluent remains within a mixing layer depth D, defined as the vertical distance from the ground to the base of the stable layer. For the model calculations, σ_z is considered to increase in the downwind direction until it reaches a distance x_T at which $\sigma_z = 0.47$ D. At this distance, pollutant concentrations at the base of the stable layer will be one-tenth that at the plume centerline. Up to this distance, the Gaussian vertical distribution is assumed. At distance x_T, the trapping effect of the elevated stable layer begins to be effective, and uniform mixing below the base of the stable layer is assumed to occur at downwind distance $2x_T$. For distances $x \geq 2x_T$, the average concentration due to a point is calculated with the assumption of full mixing layer:

$$\chi = \frac{Q(c-y)}{Duc^2} \qquad \text{EQUATION 5}$$

For distances between x_T and $2x_T$, X is determined by a linear interpolation between Equation 2, evaluated at X_T and Equation 5, evaluated at $2x_T$. A similar expression is used for the area sources.

Calculation of annual averages

For each receptor, an estimate of X due to each source is obtained by calculating the concentration for each wind speed class, wind direction, and stability class. The annual average concentrations due to all sources, $\overline{X}$, is then obtained by summing all concentrations and weighing each one according to its frequency for the particular wind direction, wind speed class, and stability class. The average concentration is:

$$\bar{\chi} = \sum_{K} \sum_{L} \sum_{J} F(J,K,L) \quad \chi(J,K,L) \qquad \text{EQUATION 6}$$

where

F(J,K,L) = normalized frequency during the period of interest for wind direction interval K, wind speed class J, and stability class L,

x(J,K,L) = average ground-level concentration calculated from Equations B-2 and B-4 as appropriate.

The total average annual concentration at a specific receptor due to all sources is obtained by summing the results of Equation 6 for all sources. For each of the 16 wind direction intervals, wind speed is defined in six categories and stability class in five categories, where stability class 1 is very unstable and stability 5 is stable. Thus, a three-dimensional array of 480 categories is established. However, only a few wind directions result in nonzero contributions for specific source-receptor pairs.

Model application

Site specific analysis of a coal mine does not require some of the ERTAQ features discussed above. Each mine was considered a single area source emitting from the surface, so multiple source features were not used. In addition, the pollutants modeled, CO, TSP, NO_x, and SO_2, were assumed to be passive, so no exponential decay factor was applied.

The concept of plume rise does not pertain to a coal mine; however an initial mixing depth over the area of ten meters was assumed. This feature allows the pollutant modeled to form "puffs" ten meters deep before dispersing downwind. Mixing depths used to simulate trapping conditions were taken from Holzworth (EPA, 1972). They are shown in Table VI-18.

Ideal use of the model requires inputting a stability wind rose. This is a joint frequency distribution of stability classes, wind directions, and wind speeds. Since no actual wind and stability data are available from the mine sites, estimates were obtained from the Craig and Hayden weather stations and from Grand Junction.

In order to predict worst case 24-hour concentrations, a wind speed of .77 meters/second was assumed to persist for eight hours during stable conditions. No assumptions about the frequency of occurrence of these specifications were necessary in order to run the model; therefore the numerical results are dependent only on the Gaussian plume assumptions of dispersion analysis and the emissions estimates.

TABLE VI-18

Mean Mixing Heights (meters) in Northwestern Colorado (Holzworth 1972)

Season	Morning	Afternoon
Winter	329	1,160
Spring	628	3,166
Summer	307	3,940
Fall	273	2,133
Annual	384	2,600

In order to estimate the frequency of occurrence of the worst case 24-hour concentrations predicted, it was necessary to examine meteorological data from Craig and Hayden measured for the Yampa project and from the National Weather Service data from Grand Junction.

Upper-level temperature soundings used to determine atmospheric stability were taken near Craig and Hayden during the following months: November, 1970; March, May, September and November, 1971; February, June, and November, 1972; and January, 1973. The frequency of occurrence of four stability classes determined from the soundings is shown in Table VI-19. The transitional class is not a standard Turner classification but is defined to represent all times when stable conditions are changing to unstable conditions. Transition periods occur most frequently during the late morning hours when increased solar heating dissipates a stable layer which develops during the night. The transition class is similar to Turner's stability class C.

Craig and Hayden soundings were conducted most frequently during the winter months, so the frequency distribution of stability classes is not representative of an entire year. Stability data from the National Weather Service Station in Grand Junction representing the winter months are shown in Table VI-20 for comparison. They agree remarkably well with the Craig and Hayden data; therefore the annual frequency of occurrence of each stability class observed in Grand Junction was assumed to be representative of the study area.

Next it was necessary to determine what percent each stability class occurred during down-valley flow. This distribution was provided by the

TABLE VI-19

Frequency of Stability Classes at Several Locations in Northwestern Colorado

Location	Period of Record	Unstable (A,B)[1/]	Transition (C)[1/]	Neutral (D)[1/]	Stable (E,F)[1/]
Hayden	Nov 70 - Jan 73[2/]	2.6%	15.1%	31.8%	50.5%
Craig	Nov 70 - Jan 73[2/]	4.1%	15.1%	29.5%	48.3%
Grand Junction	Winter	8.4%	12.3%	30.0%	49.3%
Grand Junction	Annual	13.2%	13.9%	32.8%	40.1%
Study Region Estimate	Annual	10.1%	14.6%	28.3%	46.2%

[1/] Turner stability class notation

[2/] Data sampling was not continuous over this period but occurred more often in winter

TABLE VI-20

Frequency of Wind Speed Classes Within Each Stability Class for Down-Valley Flow

	Wind Speed Meters Per Second						
Stability	.72	2.57	4.38	6.95	9.78	13.1	Total
Unstable (A+B)[1]	0	0	0	0	0	0	0
Transition (C)	.9	2.6	1.4	.2	.1	0	5.2
Neutral (D)	.1	.4	1.1	1.5	.9	0	4.0
Stable (E+F)	4.2	4.9	1.5	.2	0	0	10.8

[1] Turner stability class notation

Yampa project study which shows that down-valley flow at Hayden occurs about 20 percent of the time with the following stability breakdown: 11 percent stable conditions, four percent neutral conditions, five percent transition conditions, and zero percent unstable conditions. Finally it was observed that wind speeds during stable conditions were less than one mps 50 percent of the time.

Applying these estimates to the 24-hour worst case conditions to develop an estimate of the frequency of occurrence of the predicted concentrations is straightforward. Down-valley flow with stable conditions occurs 12 percent of the time; 50 percent of this, or six percent of the time, down-valley flow will occur during stable conditions at wind speeds less than one mps. Therefore the worse case predicted 24-hour concentrations will occur a maximum of 22 days/year. Because of rough approximations used in developing this estimate, and uncertainties in the emissions estimates, the actual number of days is assumed to be between 10-30 days.

Using ERTAQ to estimate annual average concentrations is more difficult because the frequencies of stability classes, wind speeds, and wind directions are used in the model itself. Therefore the model results are dependent not only on the accuracy of emissions estimates and the Gaussian plume assumptions but on the reliability of the stability wind rose frequency distribution. One of these variables, the wind direction frequency distribution, was eliminated by considering only one direction, down-valley. Because the down-valley direction is known to be the most frequent, occurring about 20 percent of the time, annual concentrations will be highest in that direction. The frequency of each stability class in the down-valley direction was discussed above. The distribution of wind speeds in each class was derived from the Yampa Project meteorological studies and is shown in Table VI-20. For lack of better data, this distribution was assumed to be representative of each mine site. The annual concentrations discussed in this text are believed to be accurate to within a factor of three.

Gaussian plume assumptions

The most important assumptions upon which equation 1 is based are the following:

1. Wind speed and direction in the vicinity of the point source are constant throughout the period of interest; wind speed is specified as an increasing function of height;
2. When the effluent enters the atmosphere, the plume rises until it reaches an equilibrium altitude; the plume center line height remains constant at all downwind distances;
3. At any downwind distance, the maximum concentration occurs at the plume centerline; the distribution of concentration values off the centerline is given by the product of two Gaussian or bell-shaped curves;
4. Concentration profiles described by the Gaussion form are not "instantaneous" plume profiles; instead they represent concentrations averaged over one hour;
5. None of the effluent is lost from the plume; therefore when the plume intersects the ground surface, it is assumed that

all material is reflected back above the ground;

6. Effluent rate is constant, and the meteorological parameters determining plume geometry are constant; (i.e., the equation represents steady-state conditions).

Rough terrain

Terrain features were not considered explicitly in the model calculations because the meteorological data base was insufficient to execute a complex terrain analysis. However terrain was included implicitly in two ways:

1. Up-valley-down-valley flow characteristics were included in the meteorological specifications; rough terrain features were therefore included insofar as they affected wind directions and stability classes corresponding to those directions;

2. Rough terrain was included by establishing an initial mixing depth of ten meters before dispersing pollutants; therefore, additional mechanical mixing generated by the terrain is implicitly accounted for.

Meteorological specifications

The mixing depth of the atmosphere was specified to simulate trapping conditions. Average climatological mixing depths for northwestern Colorado were used (Holzworth, 1972). They are shown in Table VI-18.

ERTAQ requires a stability wind rose to generate long-term concentrations. A stability wind rose is a joint frequency distribution of stability classes, wind directions, and wind speeds. Surface wind observations and upper air soundings taken for two years at the Hayden weather station for the Yampa project were used to extract a stability wind rose. The stability classes considered were: unstable, transitional (slightly unstable), neutral, and stable. The wind rose for each class is shown in Figures VI-6 through VI-9.

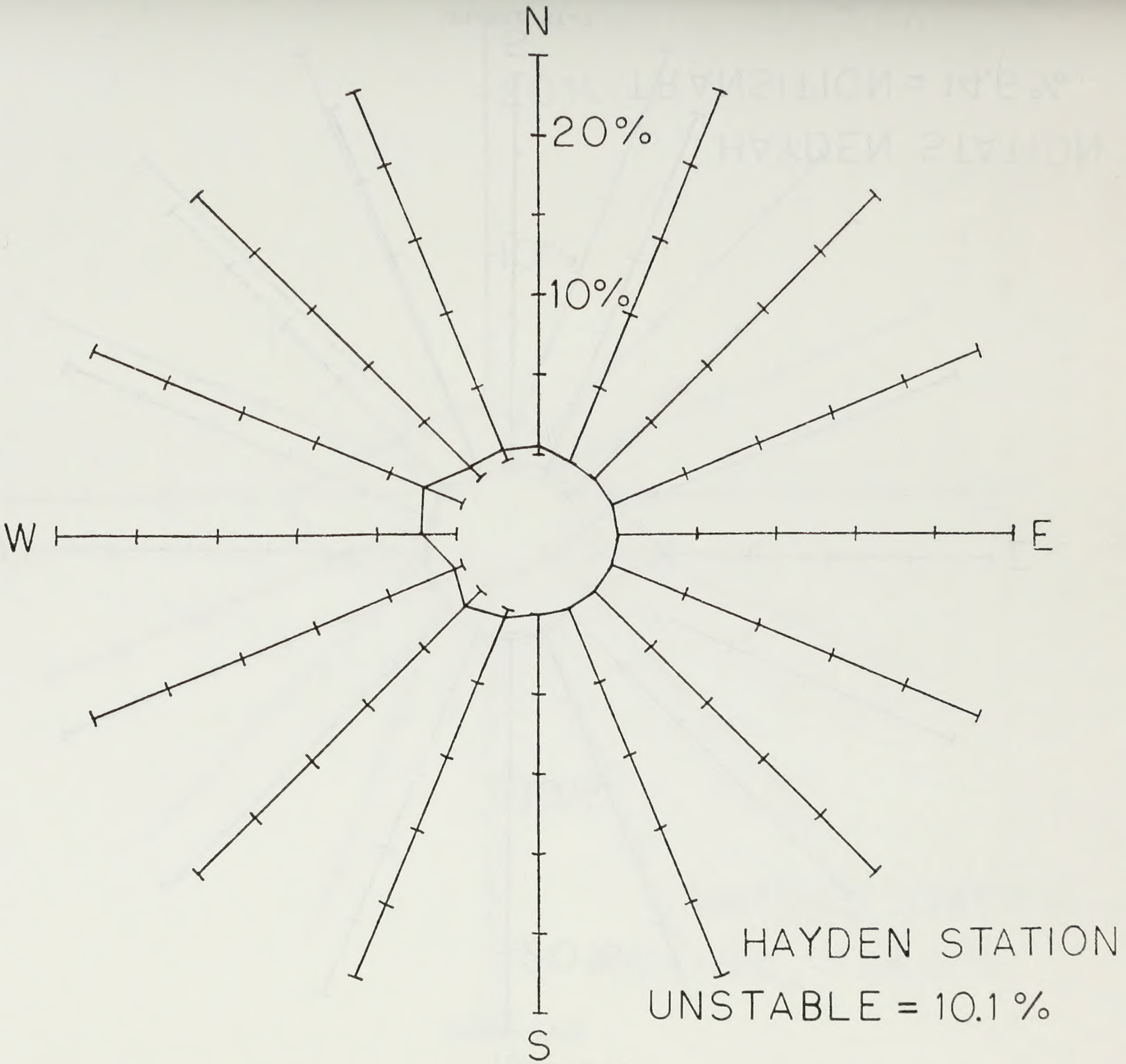


FIGURE VI-6

Wind rose for unstable conditions.

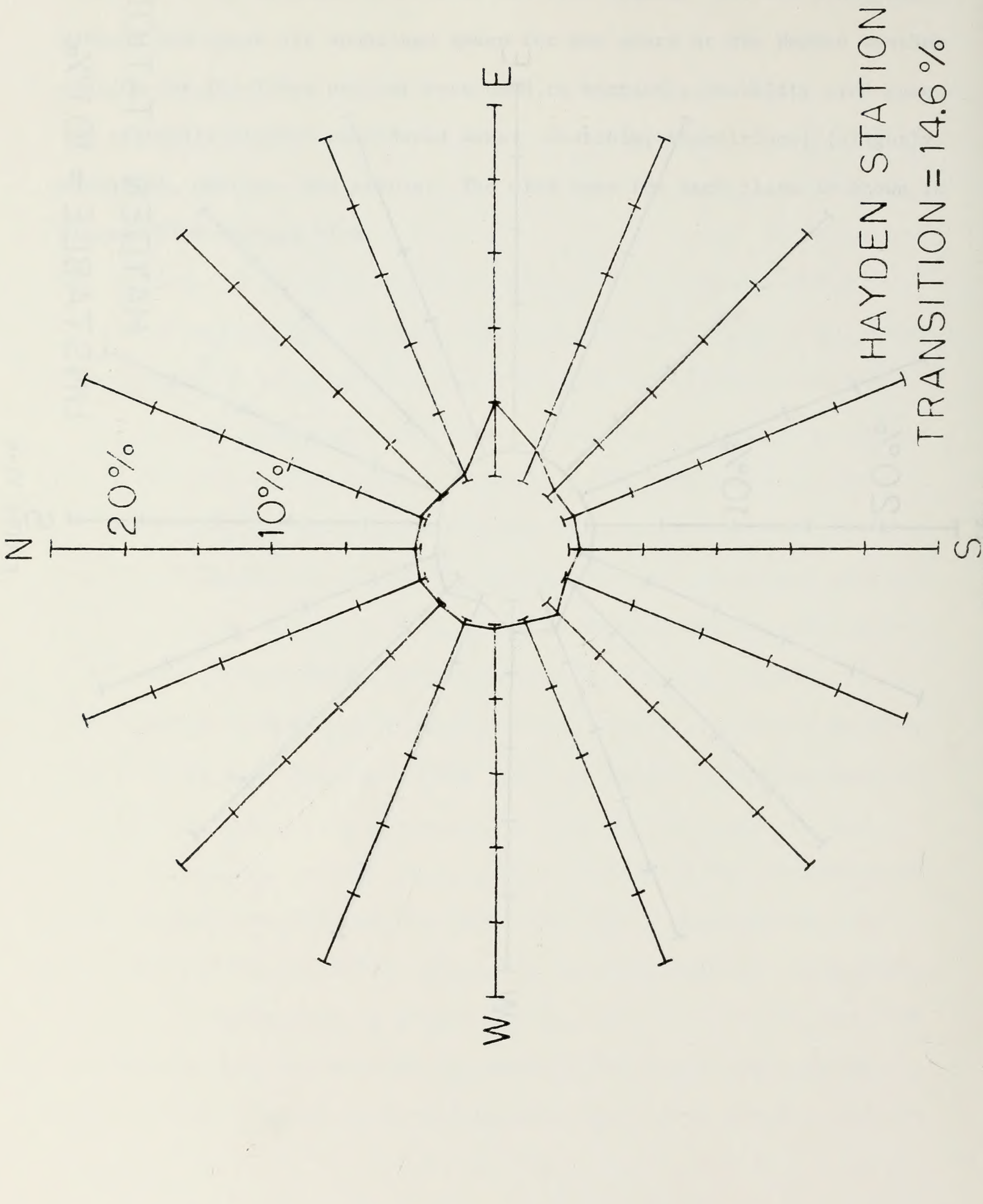


FIGURE VI-7

Wind rose for transition conditions.

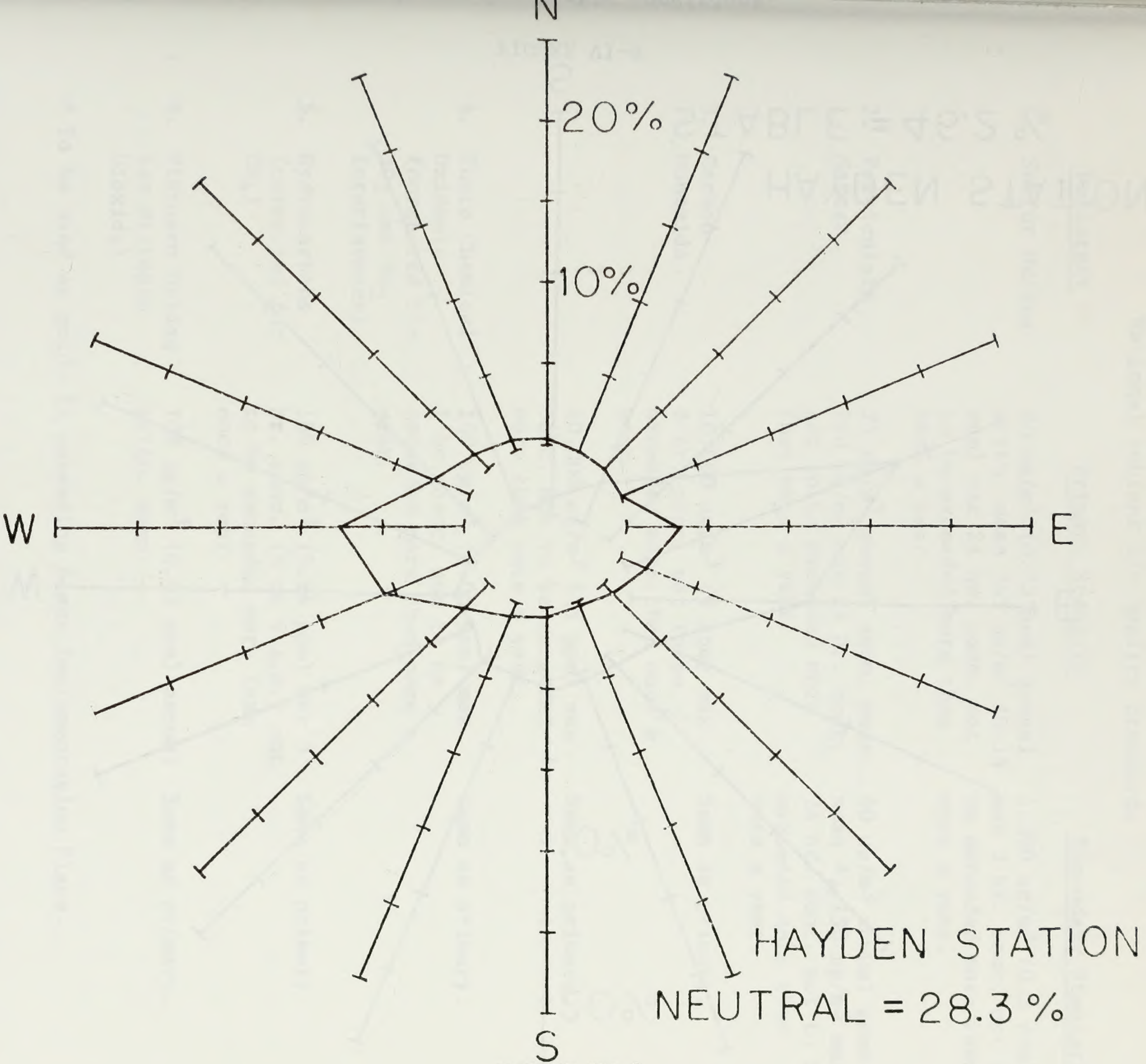


FIGURE VI-8

Wind rose for neutral conditions.

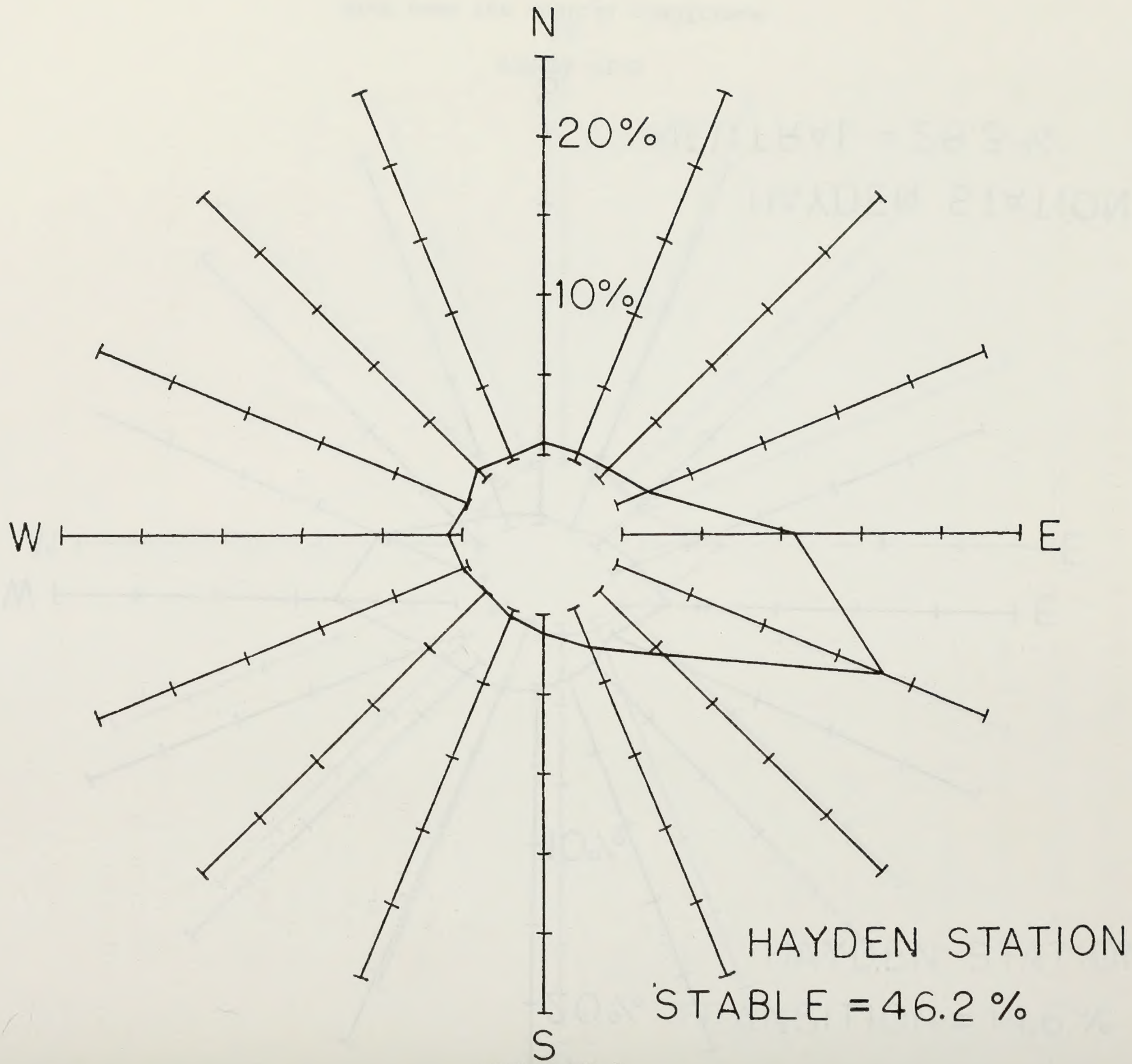


FIGURE VI-9

Wind rose for stable conditions.

TABLE VI-21

National Ambient Air Quality Standards

Pollutant	Primary Standard	Secondary Standard
1. Sulfur Oxides	80 μg/m^3 (0.03 ppm) annual arith. mean 365 μg/m^3 (0.14 ppm) max 24 hr. conc. not to be exceeded more than once a year.	1,300 μg/m^3 (0.5 ppm) max 3 hr. conc. not to be exceeded more than once a year.
2. Particulate Matter	75 μg/m^3 annual geom. mean 260 μg/m^3 max 24 hr. conc. not to be exceeded more than once a year.	60 μg/m^3 annual geom. mean *, 150 μg/m^3 max 24 hr. conc. not to be exceeded more than once a year.
3. Carbon Monoxide	10,000 μg/m^3 (9 ppm) max 8 hr. conc. not to be exceeded more than once a year.	Same as primary.
	40,000 μg/m^3 (35 ppm) max conc. not to be exceeded more than once a year.	Same as primary.
4. Photo Chemical Oxidants (corrected for NO_2 and SO_2 interference)	160 μg/m^3 (0.08 ppm) max 1 hr. conc. not to be exceeded more than once a year.	Same as primary.
5. Hydrocarbons (corrected for CH_4)	160 μg/m^3 (0.24 ppm) max 3 hr. conc. (6 to 9 a.m.) not to be exceeded more than once a year.	Same as primary.
6. Nitrogen Oxides (as Nitrogen Dioxide)	100 μg/m^3 (0.05 ppm) annual arith. mean.	Same as primary.

* To be used as guide in assessing State Implementation Plans.

TABLE VI-22

Ambient Air Standards for Metropolitan Denver Air Quality Control Region, Air Quality Control Areas, and the State of Colorado

Suspended Particulate Matter and Sulfur Dioxide
(Micrograms per cubic meter - $\mu g/m^3$)

Pollutant	Non-Designated Areas	Metro-Denver Air Quality Control Region, and Designated State Areas		
		1973	1976	1980
Suspended Particulate Matter[1/]				
Short Term[3/](a)	150	200	180	150
Long Term[4/]	45	70	55	45
Sulfur Dioxide[2/]				
One Hour Level[5/]		800 (0.28)[6/]	300 (0.10)[6/]	
Short Term[3/](b)	15 (0.0050)[6/]	300 (0.10)[6/]	150 (0.050)[6/]	55 (0.020)[6/]
Long Term[4/]		60 (0.020)[6/]	25 (0.0090)[6/]	10 (0.0040)[6/]

[1/] Measured at ambient conditions.

[2/] 0° Centigrade - 760 mm Hg (Torr.)

[3/] Short Term Level

(a) A 24-hour maximum of any 24-hour period and must not be exceeded more than once in a 12-month period.

(b) A 24-hour maximum arithmetic mean of any 24-hour period, and must not be exceeded more than once in a 12-month period.

[4/] Long Term Level - An annual arithmetic mean of all 24-hour concentrations.

[5/] One Hour Level - A 1-hour maximum arithmetic mean in any 24-hour period, and must not be exceeded more than once in any 1-month period.

[6/] (--) = Equivalent values in parts per million (1 ppm = 2860 $\mu g/m^3$ at 0°C and 760 mm Hg (Torr)).

TABLE VI-23

Allowable Incremental Increases for Class I and Class II Areas

		($\mu g/m^3$)
Pollutant	Class I	Class II
Particulate Matter		
Annual Geometric Mean	5	10
24 Hour Maximum	10	30
Sulfur Dioxide		
Annual Arithmetic Mean	2	15
24 Hour Maximum	5	100
3 Hour Maximum	25	700

Soils

APPENDIX D

TABLE OF CONTENTS
FOR
SOILS

Page

Soil Associations of the Study Region---------------------------------- VII-1
Alfisols-- VII-2
Aridosols-- VII-2
Entisols-- VII-8
Inceptisols-- VII-14
Mollisols-- VII-15

Soil Series Profile Descriptions of Energy 1 Expansion Area--------- VII-32
Haybro Series--- VII-32
Hub Series--- VII-33
Mord Series-- VII-34
Moyerson Series--- VII-35
Quander Series-- VII-35
Routt Series--- VII-36
Splitro Series--- VII-38

APPENDIX D

TABLE OF CONTENTS
FOR
SOILS

Table	Title	Page
VII-1	Environmental Characteristics Important to Soil Formations and Reclamation	VII-24-26
VII-2	Estimated Soil Properties Significant to Engineering and Their Interpretations	VII-27-31

Soil Associations of the Study Region

The general soil map (Map 8, Appendix B) shows the soil associations in Moffat, Routt, and part of Rio Blanco Counties, Colorado. A soil association is a landscape that has a distinctive proportional pattern of soils classified by the name of the major soils. The soil associations in this inventory have been grouped into five kinds of soil orders for broad interpretive purposes. Each of the broad groups and the soil associations in each group are described in the following pages and tables.

Alfisols

Typic Cryoboralfs, skeletal-Rock outcrop Association, Association #1, (287,784 acres)

This association consists of sloping to steep soils on mountain slopes and mesas (8-25+ percent slopes). Elevations range from 8,000-11,000 feet. The average annual precipitation is 24 inches+. The soil moisture regime is ustic; average annual soil temperature is less than 47°F; average summer soil temperature is more than 59°F, (cryic), and the frost-free season is 30-45 days.

This association is about 70 percent Typic Cryoboralfs, skeletal, 20 percent rock outcrop, and 10 percent unidentified minor soils, scattered on southerly slopes. These soils and land type are located in the eastern part of the study area with small areas in the extreme northwestern part.

Typic Cryoboralfs, skeletal soils are moderately-deep to deep, well-drained soils over residuum, formed in residuum and colluvium from shale and granitic rocks.

Typically they have an accumulation of organic matter, O horizon, overlying a light-colored, gravelly (more than 15 percent course fragments) loamy or silty material about 10 inches thick. The subsoil (10-40 inch layer) is a bright-colored, very gravelly (more than 35 percent coarse fragments), loamy (less than 35 percent clay) material with clay films (B2t horizon) on the ped surfaces. Base saturation is more than 35 percent. Hard bedrock is 40-60 inches.

Typic Cryoboralfs, skeletal soils are rapidly permeable; the effective rooting depth is 40-60 inches+. Available water capacity is low because of coarse fragments; surface runoff is medium and erosion hazard is low.

The principal limiting soil feature of Typic Cryoboralfs is steep slopes and the presence of stones and rock outcrops. The potential for frost heaving is moderate. Deep cuts along uphill side of roads can cause exposures of underlying rock. The large volume of coarse fragments in the subsoil, and the rock outcrops cause excavation problems, especially associated with installation of underground utilities; these soils have a poor potential for low buildings. The opportunities for topsoil are poor poor because of steep slopes, coarse fragments and thin surface layers.

Sediment yield from this association is less than 0.1 acre-foot/square mile/year (Colorado Land Use Commission). These soils are used for woodland, wildlife, recreation, and watershed. The general vegetative type is conifer. Reclamation potential is poor because of coarse fragments and steep slopes.

Aridosols

Borollic Haplargids, loamy-Ustic Torriorthents, loamy Association, Association #9, (23,077 acres)

This association consists of nearly level to moderately steep (0-25 percent slopes) soils on foothills and fans. Elevation ranges from

6,000-8,000 feet. The average annual precipitation is about 12-15 inches; moisture regime is aridic; the average annual soil temperature is less than 47°F (frigid) and the frost-free season is 60-90 days.

The association has about 60 percent Borollic Haplargids, 20 percent Ustic Torriorthents, 15 percent Argiborolls, and 5 percent of unidentified minor soils, located in the extreme southern part of Routt County.

Borollic Haplargids are moderately deep, well-drained soils over shale and sandstone. Typically, they have a thin, dark-colored, loamy surface layer, A1 horizon, less than 7 inches thick. The subsoil (10-36 inch layer, B2t horizons, is loamy, with thin clay films on the ped surfaces. The substratum is fractured bedrock. These soils are rapidly permeable; effective rooting depth is 20-36 inches. Available water capacity is moderate; surface runoff is rapid and erosion hazard is high.

Ustic Torriorthents are moderately deep, well-drained soils over shales and sandstone. Typically they have a light-colored, loamy surface layer, C1 horizon, about 10 inches thick. The substratum, C2 horizon, is a gravelly loamy material overlying fractured bedrock. These soils are rapidly permeable; effective rooting depth is 20-36 inches. Available moisture capacity is moderate; surface runoff is rapid and erosion hazard is high.

Sediment yield from this association is 0.5-1.0 acre-feet/square mile/year. These soils are used mainly for range, wildlife, watershed, and small areas of semi-wet pastures in alluvial valleys. The general vegetative type is sagebrush. Reclamation potential is fair to good.

Ustollic Haplargids, loamy Association, Association #10, (255,204 acres)

This association consists of nearly level to gently sloping soils on mesas and terraces (0-9 percent slopes). Elevation ranges from about 5,500-6,200 feet. The average annual precipitation is about 8-10 inches; soil moisture regime is aridic; the average annual soil temperature is less than 47°F but more than 59°F, mesic, and frost-free season is 120-140 days.

The association has about 85 percent Ustollic Haplargids and about 15 percent unidentified minor soils that are salty and scattered throughout the association; these soils are located in the western part of the area.

Ustollic Haplargids are deep well-drained soils over sedimentary rocks. Typically they have a thin, dark-colored, loamy surface layer, A1 horizon, less than 7 inches thick. The subsoil, 10-40 inch layer, B2t horizons, is loamy, with thin clay films on the ped surfaces. The substratum is fractured bedrock. The permeability is moderate; effective rooting depth is 60 inches+. Available water capacity is high; surface runoff is slow, and erosion hazard is high.

Sediment yield from this association is 0.5-3.0 acre-feet/square mile/year. These soils are used for recreation, irrigated cropland, range, and wildlife. The general vegetative type is saltbush-greasewood. Reclamation potential is poor due to excess salts and droughtiness.

Borollic Camborthids, clayey-Aridic Argiborolls, loamy Association, Association #21, (362,445 acres)

This association consists of gently sloping to moderately steep soils on uplands and in valleys (3-25 percent slopes). Elevations range from

6,500-9,000 feet. Average annual precipitation is 15-20 inches; soil moisture regime is aridic; average annual soil temperature is less than 47°F, frigid, and the frost-free season is 100-120 days.

The association has about 70 percent Borollic Camborthids, 25 percent Aridic Argiborolls and 5 percent of unidentified minor soils located in southeastern Moffat and west-central Routt Counties.

Borollic Camborthids are moderately deep, well-drained soils on residual sedimentary rocks. Typically they have a thin, dark-colored, loamy surface layer, A1 horizon, less than 7 inches thick. The subsoil, 10-36 inch layer, B2 horizon, is a light-colored clayey material, calcareous in the lower part. The substratum is fractured bedrock. This soil has slow permeability; effective rooting depth is 20-40 inches. Available water capacity is moderate to high; surface runoff is rapid and erosion hazard is high.

Aridic Argiborolls are deep, well-drained soils on sedimentary rocks. Typically they have a thick, dark-colored, loamy surface layer, A1 horizons, 7-20 inches thick. The subsoil, 10-40 inch layer, B2 horizons, is a dark to light-colored loamy material. The substratum is fractured bedrock. This soil has a slow permeability; effective rooting depth is 40-60 inches. Available water capacity is high; surface runoff is rapid, and erosion hazard is moderate to high.

Sediment yield from this association is 0.2-1.0 acre-feet/square mile/year. These soils are used for dry cropland, range, wildlife and small areas of irrigated cropland in stream bottoms. General vegetative type is a combination of mountain shrub and bottom. Reclamation potential is good.

Borollic Vertic Camborthids, clayey Association, Association #23, (63,801 acres)

This association consists of gently sloping to moderately steep soils on uplands and benches (3-25 percent slopes). Elevations range from about 6,500-7,000 feet. Average annual precipitation is 12-15 inches and moisture regime is aridic. Average annual soil temperature at 20 inches is 47°F, frigid; and frost-free season is 95-110 days.

The association has about 90 percent Borollic Vertic Camborthids and about 10 percent unidentified minor soils, northeast of Hayden, and north of Steamboat Springs in Routt County.

Borollic Vertic Camborthids are deep and moderately-deep, well-drained soils on sedimentary rocks. Typically they have dark-colored, clayey surface layers, A1 horizons, less than 7 inches thick, that crack when dry. The subsoil, 10-40 inch layer, B2 horizons, is a clayey material. The substratum is fractured bedrock. Permeability is slow; effective rooting depth is 20-60 inches. Available water capacity is moderate to high; surface runoff is rapid and erosion hazard is high.

Sediment yield from the association is 0.2-1.0 acre-feet/square mile/year. These soils are used for range, dry cropland, and wildlife. General vegetative type is sagebrush. Reclamation potential is fair due to semi-droughtiness.

Lithic Camborthids, loamy-Lithic Ustic Torriorthents, loamy Association, Association #24 (74,661 acres)

The association consists of steep soils on hills, breaks, and canyon walls (25 percent+ slopes). Elevation ranges from about 5,000-7,000 feet. Average annual precipitation is 8-10 inches and the moisture regime is aridic on south-facing slopes and ustic on north-facing slopes. Average annual soil temperature at 20 inches is more than 47°F. but less than 59°F, mesic, and frost-free season is about 120-140 days.

The association has about 45 percent Lithic Camborthids, 40 percent of Lithic Ustic Torriorthents, and about 15 percent of unidentified minor soils, located near the city of Rangely in Rio Blanco County.

Lithic Camborthids are shallow, well-drained soils on sedimentary rocks. Typically these soils have a dark-colored, loamy surface layer, A1 horizon, less than 7 inches thick. The subsoil, (10-20 inch layer), B2 horizon, is an altered, light-colored, loamy material that may have free carbonates. The substratum is fractured bedrock. Permeability is slow; effective rooting depth is less than 20 inches. Available water capacity is low-very low; surface runoff is rapid; erosion hazard is high-very high.

Lithic Ustic Torrenthents are shallow, well-drained soils on sedimentary rocks. Typically they have a light-colored loamy surface layer, A1 horizon, less than 7 inches thick. The upper substratum, 10-20 inch layer, C horizon, is a calcareous, loamy material that may be strongly alkaline. The lower substratum is fractured bedrock. Permeability is slow; effective rooting depth is less than 20 inches. Available water capacity is low-very low; surface runoff is rapid and erosion hazard is high-very high.

The sediment yield from the association is 0.5-3.0 acre-feet/square mile/year. These soils are used for range, woodland, wildlife, and watershed. General vegetative type is pinyon-juniper. Reclamation potential is poor due to excess slope and droughtiness.

Typic Torriorthents, clayey (shallow) Association, Association #33, (23,077 acres)

This association consists of gently sloping to steep soils on breaks (3-25 percent slopes). Elevation ranges from 5,000-6,000 feet. Average annual precipitation is 8-10 inches; moisture regime is aridic. Average annual soil temperature at 20 inches is more than 47°F, but less than 59°F, mesic, and frost-free season is about 120-140 days.

The association has about 90 percent Typic Torriorthents and about 10 percent of unidentified minor soils; they are located at Rangely in Rio Blanco County.

Typic Torriorthents are shallow, well-drained soils on sedimentary rocks. Typically they have a light-colored, calcareous, salty, clayey surface layer, Al horizon, less than 7 inches thick. The substratum, 7-20 inch layer, C horizon, is a light-colored, calcareous, salty, and clayey material. The underlying material is fractured shale. Permeability is slow; effective rooting depth is less than 20 inches. Available water capacity is low-very low; surface runoff is rapid-very rapid; erosion hazard is high-very high.

The sediment yield from this association is 1.0-3.0 acre-feet/square mile/year. These soils are mainly used for urban development, range, and wildlife. General vegetative type is saltbush. Reclamation potential is poor due to excess salts and droughtiness.

Ustic Torriorthents, loamy-Borollic Camborthids, loamy Association, Association #34, (416,743 acres)

This association consists of gently sloping to moderately steep soils on alluvial fans and floodplains (3-25 percent slope). Elevation ranges from 6,000-7,000 feet. Average annual precipitation is 8-12 inches, and the soil moisture regime is torric bordering on ustic. Average annual soil temperature at 20 inches is less than 47°F, and the difference between summmer and winter temperatures is more than 9°F, frigid. Frost-free season is 100-120 days.

The association has about 50 percent Ustic Torriorthents, 45 percent Borollic Camborthids, and 5 percent of unidentified minor soils, located in the north-central part of Moffat County.

Ustic Torriorthents are deep, well-drained soils on alluvial fans. Typically these soils have a light-colored, calcareous, salty, loamy surface layer, A1 horizon, less than 7 inches thick. The substratum, 7-40 inch layer, C horizons, is a light-colored, calcareous, salty, and loamy material. Permeability is rapid; effective rooting depth is 40-60 inches. Available water capacity is high; surface runoff is medium; erosion hazard is high to very high.

Borollic Camborthids are deep, well-drained soils on floodplains. Typically they have a dark-colored, loamy surface layer, A1 horizon, about 10 inches thick. The subsoil, (10-40 inch layer), has a light-colored, altered, B2 horizon, loamy material, calcareous in the lower part. The substratum, 40-60 inch layer, C horizon, is a calcareous loamy material. Permeability is slow; effective rooting depth is 40-60 inches. Available water capacity is high; surface runoff is medium; erosion hazard is high-very high.

Sediment yield from this association is 0.5-3.0 acre-feet/square mile/year. These soils are used mainly for range and wildlife. General vegetative type is saltbush on the Torriorthents and sagebrush on the Camborthids. Reclamation potential is poor due to droughtiness and excess salts.

Ustic Torriorthents, loamy, frigid-Aridic Argiborolls, loamy Association, Association #35, (1,140,275 acres)

This association consists of nearly level to moderately steep soils on plains or mesas (0-25 percent slopes). Elevations range from 6,000-7,500 feet. The average annual precipitation is 12-15 inches; soil moisture regime is aridic bordering on ustic. Average annual soil temperature is less than 47°F, frigid, and the frost-free season is 60-90 days.

The association has about 60 percent Ustic Torriorthents, 20 percent Aridic Argiborolls, and 20 percent of unidentified minor soils scattered throughout. These soils are located in the north-central area from the Utah State line to Craig, in Moffat County.

Ustic Torriorthents are deep, well-drained soils in mixed alluvium form, from sedimentary rocks. Typically Ustic Torriorthents have a light-colored loamy surface layer, A1 horizon, about 10 inches thick. The substratum, 10-40 inch layer, C1 horizon, is a light-colored, loamy material about 24 inches thick. The underlying layer, C2 horizon, is a light-colored, calcareous, loamy material extending to 40 inches+. Hard bedrock is 40-60 inches+.

Ustic Torriorthents are moderately permeable; effective rooting depth is 40-60 inches. Available water capacity is high and available moisture is influenced by spring and late summer rains; June and July are the driest months. Surface runoff is slow, and erosion hazard is moderate.

Aridic Argiborolls are deep, well-drained soils over sandstone and shale, formed in residuum from sedimentary rocks. Typically Aridic Argiborolls have a dark-colored, loamy surface layer, A1 horizon, about 10 inches thick. The subsoil, 10-40 inch layer is loamy material with thin clay films on ped surfaces, B2t horizon. Hard bedrock is 40-60 inches.

Aridic Argiborolls are moderately permeable; effective rooting depth is 40-60 inches. Available water capacity is high; available moisture is influenced by spring and late summer rains; June and July are the driest months. Surface runoff is slow, and erosion hazard is low.

The sediment yield from this association is 0.2-1.0 acre-feet/square mile/year. These soils are used for range, dry cropland, irrigated cropland, community development, wildlife, recreation, and watershed. General vegetative type is sagebrush with scattered areas of saltbush. Reclamation potential is good.

Lithic Ustic Torriorthents, loamy-Ustic Torriorthents, loamy Association, Association #41, (358,372 acres)

This association consists of moderately steep and steep soils on mesas and breaks (15-25+ percent slopes). Elevation ranges from 6,000-7,500 feet. Average annual precipitation is 12-15 inches. The soil moisture regime is torric bordering on ustic, where rainfall occurs during early spring and late summer months. Average annual soil temperature is less than 47°F and the difference between summer and winter temperatures is more than 9°F, frigid; frost-free season is 100-120 days.

The association has about 65 percent Lithic Ustic Torriorthents, 30 percent Ustic Torriorthents, and 5 percent of unidentified minor soils, located in the western part of Moffat County.

Lithic Ustic Torriorthents are shallow, well-drained soils on sedimentary rocks. Typically they have a light-colored, loamy surface layer, A1 horizon, less than 7 inches thick. The substratum, 7-20 inch layer, C horizon, is a light-colored, loamy material overlying fractured bedrock. Permeability is rapid; effective rooting depth is less than 20 inches. Available water capacity is low-very low; surface runoff is rapid, and erosion hazard is moderate-high.

Ustic Torriorthents are moderately deep, well-drained soils on sedimentary rocks. Typically, these soils have a light-colored, loamy surface layer, A1 horizon, less than 7 inches thick. The substratum, 10-40 inch layer, C horizons, is a light-colored, calcareous, loamy material overlying fractured sedimentary bedrock. Permeability is moderate; effective rooting depth is 20-40 inches. Available water capacity is moderate-high; surface runoff is rapid, and erosion hazard is moderate-high.

Sediment yield from this association is 0.2-1.0 acre-feet/square mile/year. These soils are mainly used for range, recreation, and wildlife. General vegetative type is sagebrush-grass and scattered pinyon-juniper. Reclamation potential is good.

Lithic Ustic Torriorthents, loamy-Rock outcrop Association, Association #42 (143,891 acres)

This association consists of moderately-steep to steep soils on breaks and canyon walls (15-25+ percent slopes). Elevation ranges from 5,000-8,000 feet. Average precipitaion is 8-15 inches; soil moisture regime is ustic where rainfall occurs during early spring and late summer months. Average annual soil temperature is more than 47°F. but less than 59°F, mesic; frost-free season is 100-140 days.

The association has about 60 percent Lithic Ustic Torriorthents and 40 percent rock outcrop. These soils and land type are located along the Utah State line west of Rangely in Rio Blanco County and in the northwest part of Moffat County.

Lithic Ustic Torriorthents are shallow, well-drained soils on sedimentary rocks. Typically they have a light-colored, loamy surface layer, A1 horizon, less than 7 inches thick. The substratum, 7-20 inch layer, C horizon, is a light-colored, loamy material overlying fractured bedrock. Permeability is moderate; effective rooting depth is less than 20 inches. Available water capacity is low-very low; surface runoff is rapid and erosion hazard is high. Rock outcrop consists of exposures of bare rock.

The sediment yield from this association is 0.5-3.0 acre-feet/square mile/year. These soils are used mainly for wildlife, range, and woodland. General vegetative type is pinyon-juniper. Reclamation potential is poor due to excess slope, rock outcrop and semi-droughtiness.

Ustic Torripsamments Association, Association #45, (50,226 acres)

This association consists of gently-sloping to moderately-steep soils on uplands (3-25 percent slopes). Elevation ranges from 6,000-6,500 feet. Average precipitation is 12-15 inches; soil moisture regime is torric bordering on ustic where rainfall occurs during early spring and late summer months. Average annual soil temperature is less than 47°F, and the difference between summer and winter temperature is more than 9°F, frigid; frost-free season is 100-120 days.

The association has about 95 percent Ustic Torripsamments and 5 percent of unidentified minor soils located west of Maybell in Moffat County. These soils are deep excessively-drained soils on sandy plains. Typically they have a light-colored sandy surface layer, A1 horizon, less than 7 inches thick. The substratum, 10-40 inch layer, C horizon, is a light-colored sandy material. Permeability is rapid; effective rooting depth is 40-60 inches. Available water capacity is low; surface runoff is slow; wind erosion hazard is high.

Sedimentation yield from this association is 0.1-0.2 acre-feet/square mile/year. These soils are used mainly for range and wildlife. General vegetative type is bitterbush. Reclamation potential is fair due to droughtiness.

Inceptisols

Pergelic Cryumbrepts, sketetal-Pergelic Cryochrepts, skeletal-Rock Association, Association #47, (21,720 acres)

This association consists of sloping to steep soils on high mountain ridges and peaks (8-25+ percent slopes). Elevations range from about 11,000-12,000+ feet. Average annual precipitation is more than 24 inches and falls mostly as snow; soil moisture regime is udic, that is never dry; the soil has a permafrost or thaws in summer, if rock is between 50 centimeters to one meter of the surface. Annual soil temperature is less than 32°F, pergelic, and frost free season is less than 30 days.

This association is about 45 percent Pergelic Cryumbrepts, skeletal, 35 percent Pergelic Cryochrepts, skeletal; and 20 percent rock outcrop, located along the eastern edge of Routt County.

Pergelic Cryumbrepts, and Pergelic Cryochrepts are deep, well-drained soils formed in sedimentary rocks and are found over residuum. Rock outcrop consists of exposures of bare rock.

Sediment yield from this association is very low, less than 0.1 acre-feet/square mile/year. These soils have a poor potential for low buildup. Their principal limiting soil features are steep slopes, permafrost, and the presence of stones and rock outcrop. The potential for frost heave is not rated, but mass wasting is prevalent; deep cuts along uphill side of roads can cause exposures of bare rock, thaw the permafrost, and cause the slope to fail. Large volumes of coarse fragments cause excavation problems; opportunities for topsoil are poor because of steep slopes and coarse fragments. These soils are used for woodland, recreation, and watershed and wildlife. Reclamation potential is poor due to slope, coarse fragments, and a very short growing season.

Mollisols

Aridic Argiborolls, clayey-Aridic Haploborolls, clayey Association, Association #52, (51,584 acres)

This association consists of sloping to steep soils on mountain slopes (9-25 percent slopes). Elevation ranges from 6,000-8,000 feet. Average annual precipitation is 14-20 inches; the moisture regime is ustic. Average annual soil temperature is less than 47°F, and the difference between summer and winter temperatures is more than 9°F, frigid; frost-free season is 100-130 days.

The association has about 60 percent Aridic Argiborolls, 20 percent Aridic Haploborolls, and 10 percent of unidentified minor soils, near Meeker in Rio Blanco County.

Aridic Argiborolls are moderately-deep, well-drained soils on clayey sedimentary rocks. Typically they have a dark-colored, clayey surface layer, Al horizons, 7-20 inches thick, that does not crack to the surface. The subsoil, 10-40 inch layer, B2t horizon, is a light to dark-colored, clayey material, with thin clay films on the ped surfaces. The substratum is fractured bedrock (shale). Permeability is slow; effective rooting depth is 20-40 inches. Available water capacity is moderate-high; surface runoff is rapid and erosion hazard is high-very high.

Aridic Haploborolls are deep, well-drained soils on clayey sedimentary rocks. Typically they have a dark-colored, clayey surface layer, Al horizon, 7-20 inches thick, that becomes dry during the growing season. The subsoil, 10-40 inch layer, B2 horizons, is a dark to light-colored, clayey material. The substratum is fractured bedrock (shale). Permeability is slow; effective rooting depth ranges from less than 20 inches to 40+. Available water capacity is low to high; surface runoff is rapid and erosion hazard is high-very high. Sedimentation yield from this association is 0.5-1.0 acre-feet/square mile/year. These soils are used mainly for urban developments, range, and wildlife. General vegetative type is pinyon-juniper. Reclamation potential is fair due to excess slope.

Typic Cryoborolls, loamy-Rock outcrop Association, Association #55, (139,819 acres)

This association consists of sloping to steep soils on mountain slopes and benches (9-25 percent slopes). Elevation ranges from 7,000-9,000 feet. Average annual precipitation is 12-15 inches; moisture regime is ustic. Average annual soil temperature is more than 32°F but less than 47°F, cryic; frost-free season is 30-90 days.

The association has about 60 percent Typic Cryoborolls, 30 percent rock outcrop, and 10 percent of unidentified minor soils, located near Yampa and Round Mountain in Routt County.

Typic Cryoborolls are shallow, well-drained soils on loamy sedimentary rocks. Typically they have a dark-colored, loamy surface layer, A1 horizon, 7-20 inches thick. The subsoil, B2 horizon, 10-20 inch layer, is an altered loamy material over bedrock. Permeability is moderate; effective rooting depth is less than 20 inches. Available water capacity is very-low low; surface runoff is slow and erosion hazard is low. Rock outcrop consists of exposures of bare rock.

Sediment yield from this association is 0.1-0.2 acre-feet/square mile/year. These soils are mainly used for range and wildlife. General vegetative type is sagebrush. Reclamation potential is poor due to rock outcrop and coarse fragments.

Typic Cryoborolls, clayey-Typic Cryoboralfs, skeletal Association #56, (19,005 acres)

This association consists of moderately steep and steep soils on mountain slopes (15-25+ percent slopes). Elevation ranges from 6,000-8,000 feet. Average annual precipitation is 12-20 inches; moisture regime is ustic. Average annual soil temperature is higher than 32°F. but less than 47°F, (cryic); frost-free season is 60-90 days.

The association has about 60 percent Typic Cryoborolls, 30 percent Typic Cryoboralfs, and 10 percent of unidentified minor soils, located northwest of Meeker in Rio Blanco County.

Typic Cryoborolls are deep, well-drained minor soils on clayey sedimentary rocks. Typically they have a dark-colored, clayey surface layer, A1 horizons, 7-20 inches thick. The substratum 10-40 inch layer, C horizon, is a light-colored, clayey material; it is fractured shale bedrock. Permeability is slow; effective root depth is 40 inches+. Available water capacity is moderate-high; surface runoff is rapid and erosion hazard is moderate.

Typic Cryoboralfs are shallow to deep well-drained soils on sedimentary rocks. Typically these soils have a light-colored, gravelly surface, A1 horizon; less than 7 inches below the subsoil, 10-40 inch layer, B2t horizon, is light-colored, very gravelly, loamy material with thin clay film on ped surfaces; substratum is fractured bedrock. Permeability is slow; effective rooting depth is 10-60+ inches. Available water capacity is low to moderate; surface runoff is rapid and erosion hazard is moderate.

Sediment yield from this association is 0.2-0.5 acre-feet/square mile/year. These soils are used for range and wildlife. General vegetative type is mountain shrub and pinyon-juniper. Reclamation potential is poor due to coarse fragments and excess slope.

Typic Cryoborolls, clayey-Typic Cryorthents, clayey association, Association #57, (63,803 acres)

This association consists of moderately steep and steep soils on benches and mountain slopes (15 to 25+ percent slopes). Elevation ranges from 8,000-9,000 feet. Average annual precipitation is 12-15 inches; moisture regime is ustic; average annual soil temperature is more than 32°F but less than 47°F, cryic; frost-free season is 60-90 days.

The association has about 45 percent Typic Cryoborolls, 25 percent Typic Cryorthents, 20 percent rock outcrop, and 10 percent of unidentified minor soils; they are located in northern and southern parts of Routt and northeast part of Moffat County.

Typic Cryoborolls are deep, well-drained soils on clayey sedimentary rocks. Typically they have a dark-colored, clayey surface layer, A1 horizon, 7-20 inches thick. The subsoil, 10-40 inch layer, B2 horizon, is light-colored in the lower part; substratum is fracture shale bedrock. Permeability is slow; effective rooting depth is 40 inches+. Available water capacity is high; surface runoff is rapid and erosion hazard moderate.

Typic Cryorthents are shallow, well-drained soils on clayey sedimentary rocks. Typically they have a light-colored, clayey surface layer, A1 horizon, less than 7 inches thick. The substratum, 10-40 inch layer, C horizon, is light-colored, clayey material overlying a soft shale. Permeability is moderate; effective rooting depth is less than 20 inches. Available water capacity is low; surface runoff is rapid and erosion hazard moderate. Rock outcrop consists of exposed bare rock.

Sediment yield from this association is 0.2-0.5 acre-feet/square mile/year. These soils are mainly used for range, recreation, subdivision, and irrigated cropland. General vegetative group is sagebrush-grass. Reclamation potential is good-poor, due to a combination of excess slope and coarse fragments, or rock outcrop.

Argic Cryoborolls, loamy-Cryic Paleoborolls, loamy association, Association #59, (496,834 acres)

This association consists of sloping to steep soils on mountain slopes (9 to 25+ percent slopes). Elevation ranges from 7,000-8,000 feet. Average annual precipitation is 15-20 inches; moisture regime is ustic. Average annual soil temperature is more than 32°F but less than 47°F, cryic; frost free season is less than 90 days.

The association has about 55 percent Argic Cryoborolls, 40 percent Cryic Paleoborolls, and 5 percent of unidentified minor soils located in the eastern and northwestern part of the study area.

Argic Cryoborolls are shallow, well--drained soils on loamy sedimentary rocks. Typically they have a dark-colored, loamy surface layer, A1 horizon, 7-20 inches thick. The subsoil, 10-20 inch layer, B2 horizons, is light-colored in the lower part and has thin clay films on ped surfaces; substratum is fractured bedrock. Permeability is slow; effective rooting depth is less than 20 inches. Available water capacity is low-moderate; surface runoff is slow and erosion hazard slight.

Cryic Paleoborolls are deep, well-drained soils on basaltic and sedimentary rocks. Typically they have a dark-colored, loamy surface layer, 10-20 inches thick. The subsoil, 10-40 inch layer, B2 horizon, has a clay accumulation in the 24-40 inch layer, B^{1}2t horizon; substratum is loamy soil material above the bedrock. Permeability is moderate; effective rooting depth is 60 inches+. Available water capacity is high; surface runoff is slow and erosion hazard slight.

Sediment yield from this association is 0.1-0.2 acre-feet/square mile/year. These soils are used for range, wildlife, irrigated cropland, and watershed. General vegetative group is mountain shrub-sagebrush. Reclamation potential is fair-poor due to excess slope.

Lithic Haploborolls, skeletal-Rock outcrop Association, Association #61, (9,502 acres)

This association consists of moderately steep and steep soils on mesas and breaks (15 to 25+ percent slopes). Elevation ranges from 7,000-8,000 feet. The average annual precipitation is 15-20 inches; moisture regime is ustic. Average annual soil temperature is more than 32°F but less than 47°F, cryic; frost-free season is less than 90 days.

The association has about 60 percent Lithic Haploborolls and 40 percent rock outcrop, located near Meeker in Rio Blanco County.

Lithic Haploboralfs are shallow, well-drained soils on sedimentary rocks. Typically they have light-colored, very gravelly surface layers, A1 horizons, less than 7 inches thick. The subsoil, 10-20 inch layer, B2 horizon, is a very gravelly soil material over fractured sedimentary rocks. Permeability is moderate; effective rooting depth is less than 20 inches. Available water capacity is low; surface runoff is medium and erosion hazard moderate. Rock outcrop consists of exposures of bare rock. Sediment yield from this association is 0.5-1.0 acre-feet/square mile/year. The soils are used mainly for range and wildlife. General vegetative group is mountain shrub-aspen. Reclamation potential is poor, due to excess slope and coarse fragments, or rock outcrop.

Typic Paleborolls, clayey-Borollic Camborthids, clayey Association, Association #62, (141,177 acres)

This association consists of gently sloping to moderately steep soils on uplands (3-25 percent slopes). Elevation ranges from 6,500-8,000 feet. Average annual precipitation is 15-20 inches; moisture regime is ustic. Average annual soil temperature is less than 47°F but the summer temperature is less than 59°F, frigid; frost-free season is 90-110 days.

The association has about 55 percent Typic Paleborolls, 35 percent Borollic Camborthids, and 10 percent of unidentified minor soils; these soils are located in the central part of Routt County near Steamboat Springs.

Typic Paleborolls are deep, well-drained soils on clayey sedimentary rocks. Typically they have a dark-colored, clayey surface layer, A1 horizon, 7-20 inches thick. The next layer is light-colored, A2 horizon, overlying a clayey B^{1}2t horizon that consists of thick clay films on ped surfaces extending 60 inches or more to weathered shale bedrock. Permeability is slow; effective root depth is 60 inches+. Available water capacity is high; surface runoff is medium and erosion hazard moderate.

Borollic Camborthids are deep, well-drained soils on clayey sedimentary rocks. Typically they have a dark-colored, clayey surface layer, A1 horizon, about 7 inches thick. The subsoil, 10-40 inch layer, B2 horizon, is a light-colored, clayey soil material extending from 40-60 inches; substratum is soft shale bedrock.

Permeability is slow; effective rooting depth is 40-60 inches. Available water capacity is high; surface runoff is medium and erosion hazard moderate.

Sediment yield from this association is 0.2-0.5 acre-feet/square mile/year. These soils are used mainly for range, wildlife, and dry cropland, with some irrigated pasture in the narrow bottoms. General vegetative group is mountain shrub-bottom. Reclamation potential is good.

Soils

TABLE VII-1

Environmental Characteristics Important to Soil Formation and Reclamation

Soil Map Symbol	Textural Family[1]	M.A.P.[20] (inches)	Soil Temp. Regime	Growing Season (days)	Elevation (1000 feet)	Nat. Veg.[17]	Land-form[19]	Sediment Yield[6]	Reclamation Potential[18]	Present Use[16]
1	skeletal[2]	20+	cryic[7]	30-45	8-11	c	ma-ms	<0.1	p[10,11]	WL,WE,RC
9	loamy[3]	12-15	frigid[8]	60-90	6-8	s	fh-fn	0.5-1.0	f-g	RE,WE,PE
10	loamy	8-10	mesic[9]	120-140	5.5-6.2	s-g	ma-te	0.5-3.0	p[12,13]	RC,IC,RE
21	clayey[4]-loamy	15-20	frigid	100-120	6.5-9	m-b	up-vy	0.2-1.0	g	DC,IC,RE
23	clayey	12-15	frigid	95-110	6.5-7	s	up-be	0.2-1.0	f[14]	RE,DC,WE
24	loamy	8-10	mesic	120-140	5-7.5	p-j	fh-br-cy	0.5-3.0	p[11,13]	RE,WL,WE
33	clayey	8-10	mesic	120-140	5-6	t	br	1.0-3.0	p[12,13]	RE,UD,RC
34	loamy	8-12	frigid	100-120	6-7	t-s	fn-fp	0.5-3.0	p[12,13]	RE,RC,WE
35	loamy	12-15	frigid	60-90	6.5-8	s	up	0.2-1.0	g	UD,RC,WE
41	loamy	12-15	frigid	100-120	6-7.5	s-p-j	ma-br	0.2-1.0	f-g	RE,RC,WE
42	loamy	8-15	mesic	100-140	5-8	p-j	br-cy	0.5-3.0	p[10,11,14]	WE,RE,WL
45	sandy[5]	12-15	frigid	100-120	6-6.5	u	up	0.1-0.2	f[13]	WE,RE
47	skeletal	20+	pergelic[15]	<30	>11	c	mt	<0.1	p[10,11]	RC,WS
52	clayey	14-20	frigid	100-130	6-8	p-j	ms	0.5-1.0	f[11]	UD,RE,WE

Footnotes 1-20 see pages VII-25-26.

TABLE VII-1 (Cont.)

Map Symbol	Textural Family[1]	M.A.P. (inches)	Soil Temp. Regime	Growing Season (days)	Elevation (1000 feet)	Nat. Veg.[17]	Land-form[19]	Sediment Yield[6]	Reclamation Potential[18]	Present Use[16]
55	loamy	12-15	cryic	30-90	7-9	s	ms-be	0.1-0.2	p[10]	RE,WE
56	clayey-skeletal	12-20	cryic	60-90	6-8	m-p-j	ms	0.2-0.5	p[10,11]	RE,WE
57	clayey	12-15	cryic	60-90	8-9	s-r	be-ms	0.2-0.5	g-f[11]	RE,IC,UD
59	loamy	12-20	frigid	< 90	7-8.5	m-s	ms	0.1-0.2	f-p[11]	RE,IC,WE
61	skeletal	15-20	frigid	< 90	7-8	m-a	me-br	0.5-1.0	p[10,11]	RE,DC,WE
62	clayey	15-20	frigid	90-110	6.5-8	m-b	up	0.2-0.5	g	RC,WS

[1] Assume well-drained soil material (10-40 inch layer).

[2] <35% by volume is larger than 2 mm.

[3] Texture is loamy, very fine sand or finer < 35% clay, less than 35% by volume of rock fragments.

[4] Texture has > 35% by weight of clay, <35% by volume of rock fragments.

[5] Texture is sand or loamy sand, <35% by volume of rock fragments.

[6] Acre-feet per square mile per year. (Reference: Colorado Land Use Commission, 1974).

[7] Mean annual soil temperature is >32°F but < 47°F.

[8] Mean annual soil temperature is <47°F and >32°F; difference between mean summer and mean winter is >9°F.

[9] Mean annual soil temperature is 47°F-59°F.

TABLE VII-1 (Cont.)

[10] Coarse fragment.

[11] Excess slope.

[12] Excess salts.

[13] Droughty.

[14] Semi-droughty.

[15] Mean annual soil temperature is <32°F.

[16] DC, dry cropland; IC, irrigated cropland; PE, pasture; RC, recreation; RE, range; UD, urban development & subdivision; WE, wildlife; WL, woodland; WS, watershed.

[17] a, aspen; b, bottom; c, conifer; g, greasewood; j, juniper; m, mountain shrub; p, pinyon; r, grass; s, sagebrush; t, saltbush; u, bitterbrush.

[18] g, good; f, fair; p, poor.

[19] be, bench; br, break; cy, canyon; fh, foothill; fn, fan; fp, floodplain; ma, mesa; ms, mountain slope; mt, mountain top; te, terrace; up, upland; vy, valley.

[20] M.A.P. mean annual precipitation.

Soils

TABLE VII-2

Estimated Soil Properties Significant to Engineering and Their Interpretations

Soil Association							Degree and Kind of Limitation for --		Suitability As A Source of -- To a depth of 5 feet	
Number, Name and Components	Extent %	Slope %	Bedrock (inches)	Perm-eability	Shrink Swell Potential	Frost Action Potential	Septic Tank Filter-Field	Low Buildings W/O Basement	Road Fill	Sand & Gravel
1 Typic Cryoboralfs, skeletal - Rock outcrop										
Typic Cryoboralfs, skeletal	70	9-25	20-60	Rapid	Low	Moderate	Severe[6,8]	Severe[6,8]	Fair[6,8]	Unsuited
Rock outcrop	20	-	0	-	-	-	Severe[11]	Severe[11]	Poor[11]	Unsuited
Minor soils	10	-	-	-	-	-	-	-	-	-
9 Borollic Haplargids, loamy - Ustic Torriorthents, loamy										
Borollic Haplargids, loamy	60	15-25	< 20	Rapid	Low	Low	Severe[6,8]	Severe[6]	Poor[6]	Unsuited
Ustic Torriorthents, loamy	20	3-15	40-60	Rapid	Low	Low	Moderate[6]	Moderate[6,8]	Fair[14]	Unsuited
Argiborolls, loamy	15	-	-	-	-	-	-	-	-	-
Minor soils	5	-	-	-	-	-	-	-	-	-
10 Ustollic Haplargids, loamy										
Ustollic Haplargids, loamy	85	3-15	> 60	Moderate	Moderate	Low	NR	NR	NR	Unsuited
Minor soils (Camborthids?)	15	3-15	> 60	Moderate	Moderate	Low	Slight	Moderate[8]	Fair[14]	Unsuited
21 Borollic Camborthids, clayey - Aridic Argiborolls, loamy										
Borollic Camborthids, clayey	70	3-25	20-40	Slow	High	Moderate	Severe[1]	Severe[13]	Poor[13,14]	Unsuited
Aridic Argiborolls, loamy	25	3-25	20-60	Slow	High	Moderate	Severe[1]	Severe[13]	Poor[13,14]	Unsuited
Minor soils	5	-	-	-	-	-	-	-	-	-
23 Borollic Vertic Camborthids, clayey										
Borollic Vertic Camborthids, clayey	90	3-25	20-60	Slow	High	Moderate	Severe[1]	Severe[12,14]	Poor[13,14]	Unsuited
Minor soils	10	-	-	-	-	-	-	-	-	-

Footnotes: See page VII-31.

Soils

TABLE VII-2 (Cont.)

Estimated Soil Properties Significant to Engineering and Their Interpretations

Soil Association Number, Name and Components	Extent %	Slope %	Bedrock (inches)	Perm-eability	Shrink Swell Potential	Frost Action Potential	Degree and Kind of Limitation for --		Suitability As A Source of -- To a depth of 5 feet	
							Septic Tank Filter-Field	Low Buildings W/O Basement	Road Fill	Sand & Gravel
24 Lithic Camborthids, loamy - Lithic Ustic Torriorthents, loamy										
Lithic Camborthids, loamy	45	15-25+	<20	Slow	Low	Low	Severe[8,11]	Severe[8,11]	Poor[8]	Unsuited
Lithic Ustic Torriorthents, loamy	40	15-25+	<20	Slow	Low	Low	Severe[8,11]	Severe[8,11]	Poor[8]	Unsuited
Minor soils	15	-	-	-	-	-	-	-	-	-
33 Typic Torriorthents, clayey (shallow)										
Typic Torriorthents, clayey (shallow)	90	3-25	20	Slow	High	Low	Severe[6,8,13]	Severe[6,8,13]	Poor[8,14]	Unsuited
Minor soils	10	-	-	-	-	-	-	-	-	-
34 Ustic Torriorthents, loamy - Borollic Camborthids, loamy										
Ustic Torriorthents, loamy	50	3-25	40-60	Rapid	Low	Low	Moderate[6,8]	Moderate[8]	Fair[8,14]	NR
Borollic Camborthids, loamy	45	3-25	40-60	Slow	High	Low	Severe[1]	Severe[13,14]	Poor[13,14]	Unsuited
Minor soils	5	-	-	-	-	-	-	-	-	-
35 Ustic Torriorthents, loamy - Aridic Argiborolls, loamy										
Ustic Torriorthents, loamy	60	3-9	40-60	Moderate	Low	Moderate	Moderate[6]	Slight	Fair[14]	NR
Aridic Argiborolls, loamy	20	0-9	40-60	Moderate	Low	Moderate	Moderate[6]	Slight	Fair[14]	NR
Minor soils	20	0	0	0	0	-	-	-	-	-
41 Lithic Ustic Torriorthents, loamy - Ustic Torriorthents, loamy										
Lithic Ustic Torriorthents, loamy	65	15-25+	<20	Rapid	Low	Low	Severe[6,8]	Severe[6,8]	Poor[6,8]	Unsuited
Ustic Torriorthents, loamy	30	15-25	20-40	Moderate	Low	Low	Severe[8]	Severe[8]	Poor[8]	Unsuited
Minor soils	5	-	-	-	-	-	-	-	-	-

Footnotes: See page VII-31.

TABLE VII-2 (Cont.)

Estimated Soil Properties Significant to Engineering and Their Interpretations

Soil Association Number, Name and Components	**Extent %**	**Slope %**	**Bedrock (inches)**	**Perm-eability**	**Shrink Swell Potential**	**Frost Action Potential**	**Degree and Kind of Limitation for --** Septic Tank Filter-Field	**Degree and Kind of Limitation for --** Low Buildings W/O Basement	**Suitability As A Source of --** Road Fill (To a depth of 5 feet)	**Suitability As A Source of --** Sand & Gravel (To a depth of 5 feet)
42 Lithic Ustic Torriorthents, loamy - Rock outcrop										
Lithic Ustic Torriorthents, loamy	60	15-25	<20	Moderate	Low	Low	Severe^{6,8}	Severe^{6,8}	Poor^{6,9}	Unsuited
Rock outcrop	40	-	0	-	-	-	Severe^{11}	Severe^{11}	Poor^{11}	Unsuited
45 Ustic Torripsamments										
Ustic Torripsamments	95	3-15	40-60	Rapid	Low	Low	Slight^{7}	Slight	Good	Good for sand
Minor soils	5	-	-	-	-	-	-	-	-	Unsuitable for gravel
47 Pergelic Cryumbrepts, skeletal - Pergelic Cryochrepts, skeletal - Rock outcrop										
Pergelic Cryumbrepts, skeletal	45	9-25+	60+	NR	NR	NR	Severe^{8}	Severe^{8}	NR	Unsuited
Pergelic Cryochrepts, skeletal	35	9-25+	60+	MR	NR	NR	Severe^{8}	Severe^{8}	NR	Unsuited
Rock outcrop	20	-	-	-	-	-	-	-	-	-
52 Aridic Argiborolls, clayey - Aridic Haploborolls, clayey										
Aridic Argiborolls, clayey	60	9-25	<20-40+	Slow	High	Moderate	Severe^{1,6,8}	Severe^{8,13}	Poor^{13,14}	Unsuited
Aridic Haploborolls, clayey	30	9-25	20-40+	Slow	Moderate	Moderate	Severe^{6,8}	Severe^{6,8}	Poor^{6}	Unsuited
Rock outcrop	10	-	0	-	-	Severe^{11}	Severe^{11}	Severe^{11}	Poor^{11}	Unsuited
55 Typic Cryoborolls, loamy - Rock outcrop										
Typic Cryoborolls, loamy	60	9-25	<20	Moderate	Low	Low	Severe^{6}	Severe^{6,8}	Poor^{6,11}	Unsuited
Rock outcrop	30	-	0	-	-	-	Severe^{11}	Severe^{11}	Poor^{11}	Unsuited
Minor soils	10	-	-	-	-	-	-	-	-	-

Footnotes: See page VII-31.

TABLE VII-2 (Cont.)

Estimated Soil Properties Significant to Engineering and Their Interpretations

Soil Association Number, Name and Components	Extent %	Slope %	Bedrock (inches)	Permeability	Shrink Swell Potential	Frost Action Potential	Degree and Kind of Limitation for -- Septic Tank Filter-Field		Suitability As A Source of -- To a depth of 5 feet Road Fill	
							Septic Tank Filter-Field	Low Buildings W/O Basement	Road Fill	Sand & Gravel
56 Typic Cryoborolls, clayey - Typic Cryoboralfs, skeletal										
Typic Cryoborolls, clayey	60	15-25+	>40	NR	NR	NR	Severe[8]	Severe[8]	NR	Unsuited
Typic Cryoboralfs, skeletal	30	15-25+	10-60+	NR	NR	NR	Severe[8]	Severe[8]	NR	Unsuited
Rock outcrop	10	-	0	-	-	-	Severe[11]	Severe[11]	Poor[11]	Unsuited
57 Typic Cryoborolls, clayey - Typic Cryorthents, clayey										
Typic Cryoborolls, clayey	45	15-25+	>40	NR	NR	Moderate	Severe[8]	Severe[8]	NR	Unsuited
Typic Cryorthents, clayey	25	25+	<20	Moderate	Low	Moderate	Severe[6,8,11]	Severe[6,8,11]	Poor	Unsuited
Rock outcrop	20	-	0	-	-	-	Severe[11]	Severe[11]	Poor[11]	Unsuited
Minor Soils	10	-	-	-	-	-	-	-	-	-
59 Argic Cryoborolls, loamy - Cryic Paleoborolls, loamy										
Argic Cryoborolls, loamy	55	3-25	>60	Slow	High	High	Severe[1,8]	Severe[8,13]	Poor[13,14]	Unsuited
Cryic Paleoborolls, loamy	40	9-25+	<20	Moderate	Low	Moderate	Severe[6,8]	Severe[6,8]	Poor[6,8]	-
Minor soils	5	-	-	-	-	-	-	-	-	-
61 Lithic Haploborolls, skeletal - Rock outcrop										
Lithic Haploborolls, skeletal	60	15-25+	20	Moderate	Low	Low	Severe[6,8]	Severe[6,8]	Poor[6,9]	Unsuited
Rock outcrop	40		0	-	-	-	Severe[11]	Severe[11]	Severe[11]	Unsuited
62 Typic Paleborolls, clayey - Borollic Camborthids, clayey										
Typic Paleborolls, clayey	55	3-15	60	Slow	High	High	Severe[1]	Severe[13,14]	Poor[13,14]	Unsuited
Borollic Camborthids, clayey	35	3-25	40-60	Slow	High	High	Severe[1]	Severe[13,14]	Poor[13,14]	Unsuited
Minor soils	10	-	-	-	-	-	-	-	-	-

Footnotes: See page VII-31.

Soils

TABLE VII-2 (Cont.)

Estimated Soil Properties Significant to Engineering and Their Interpretations

[1]	Slow permeability
[6]	Depth to rock
[7]	Possible pollution hazard to water supplies
[8]	Excess slope
[9]	Coarse fragments
[11]	Rock outcrops and/or shallow soils
[13]	Shrink-Swell potential
[14]	Engineering Soil Classification
NR	Not rated because of variability
-	Not applicable or information not available

Haybro Series

A typical profile of the Haybro series located 2,025 feet north and 900 feet east of the southwest corner of Section 22, T.5N., R.87W. is shown below.

A1--0-3 inches, light olive-brown (2.5Y 5/3) silty clay, olive-brown (2.5Y 4/3) moist; strong very fine granular structure; soft, very friable; noncalcareous, mildly alkaline; clear smooth boundary.

B2--3-10 inches, light olive-brown (2.5Y 5/3) silty clay, olive-brown (2.5Y 4/3) moist; moderate coarse angular blocky structure breaking to moderate fine angular blocks; slightly hard, very friable, very plastic; many slickensides; strongly calcareous; moderately alkaline; gradual wavy boundary.

B3--10-18 inches, light olive-brown (2.5Y 5/3) silty clay, olive-brown (2.5Y 4/3) moist; weak to moderate coarse angular blocky structure; hard, very plastic; many slickensides; very strongly calcareous; strongly alkaline; diffuse wavy boundary.

Clca--18-35 inches, light olive-brown (2.5Y 5/3) silty clay, olive brown (2.5Y 4/3) moist; massive to very weak coarse angular blocky structure; extremely hard, very plastic; slickensides; calcium carbonate and calcium sulfate occurring as crystals, as concretions, and in thin seams and streaks; very strongly calcareous; stongly alkaline; gradual and wavy boundary.

R--35-60 inches, dark gray calcareous and gypsiferous shale. The principal variations are that depth to the lime layer near surface to 10 inches. The solum is 12-30 inches thick. Bedrock is 20-40 inches deep.

Hub Series

Representative profile of Hub loam in timber, located 2,640 feet east, 1,050 feet south of the northwest corner of Section 1, T.1S., R.84W. is shown below.

A1--0-7 inches, dark grayish-brown (10YR 4/2) loam, very dark-brown (10YR 2/2) moist, weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

A2--7-13 inches, light gray (10YR 7/2) loam, dark grayish-brown (10YR 4/2) moist; weak medium prismatic structure that parts to weak medium subangular blocks; soft, very friable; neutral; clear smooth boundary.

B2t--13-24 inches, pale-brown (10YR 6/3) clay loam, dark-brown (10YR 4/3) moist; moderate medium prismatic structure that parts to moderate fine subangular blocks; thin continuous clay films on ped faces; neutral; clear smooth boundary.

C--24-60 inches, very pale-brown (10YR 8/3) loam, pale-brown (10YR 6/3) moist; massive; soft, very friable; neutral.

Mord Series

Described below is a typical profile of Mord loam under native vegetation located near the center of Section 26, T.10N., R.85W. (Routt County)

A11--0-8 inches, grayish-brown (10YR 5/2) loam, very dark-brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; 10 percent gravel; noncalcareous; clear and smooth boundary.

A12--8-14 inches, dark grayish-brown (10YR 4/2) loam, very dark-grayish-brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocks; soft, very friable; 10 percent gravel; noncalcareous; clear smooth boundary.

A2--14-21 inches, brown (10YR 6/3) loam, dark-brown (10YR 4/3) moist; weak medium prismatic structure parting to weak medium and fine subangular blocks; soft, very friable; 10 percent gravel; noncalcareous; clear and smooth boundary.

B&A--21-35 inches, pink (7.5YR 7/4) clay loam, brown (7.5YR 5/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocks; slightly hard, friable moist; 10 percent gravel; noncalcareous; few mottles of very dark-brown (10YR 2/2); thin and patchy clay films on some ped faces; clear smooth boundary.

B2t--35-60 inches, light-brown (7.5YR 6/4) clay, dark-brown (7.5YR 4/4) moist; strong medium prismatic structure parting to strong fine subangular blocks; hard, firm; 10 percent gravel; thick clay films on ped faces.

Moyerson Series

Shown below is a typical profile of Moyerson clay in native range located 1/4 mile west, 1/4 mile north of the southeast corner of Section 24, T.1N., R.85W.

A1--0-5 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish-brown (2.5Y 3/2) moist; dark grayish-brown (2.5Y 4/2) crushed; moderate to strong fine granular and crumb structure; soft very friable; vesicular crust approximately 1/4 of an inch thick; weakly calcareous, moderately alkaline; clear smooth boundary.

C--5-15 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish-brown (2.5Y 4/2) moist; dark grayish-brown (2.5Y 4/2) crushed; very weak fine prismatic structure breaking to strong fine angular blocks; soft to slightly hard; very friable; strongly calcareous, moderately alkaline; gradual wavy boundary.

R--15-20 inches, dark gray clay shale; very strongly calcareous.

Quander Series

A typical profile, in hayland, approximately 0.1 mile north, 0.4 mile east of the southwest corner of Section 22, T.1N., R.85W. is shown below.

A1--0-4 inches, dark grayish-brown (10YR 4/2) loam, very dark-brown (10YR 2/2) moist; weak, fine, granular structure; soft very friable; noncalcareous; clear, smooth boundary.

B2t--4-10 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark-brown (10YR 2/2) moist; moderate very fine subangular blocky structure; soft, very friable; noncalcareous; thin nearly continuous clay films; clear smooth boundary.

B3--10-16 inches, light brownish-gray (10YR 6/2) loam, dark grayish-brown (10YR 4/2) moist; weak to moderate fine subangular blocky structure; soft, very friable; noncalcareous; clear smooth boundary.

C--16-60 inches, dark grayish-brown (10YR 4/2) moist, sandy loam 50 to 70 percent basaltic stones and cobbles.

Routt Series

A typical profile of Routt loam, from the center of NE 1/4, Section 29, T.6N., R.85W., (Routt County), in native grass.

O1--2-0 inches, very dark-brown organic layer.

A11--0-4 inches, dark gray (10YR 4/1) loam, very dark-brown (10YR 2/2) moist; weak fine platy to weak fine granular structure; soft, very friable; noncalcareous; clean smooth boundary.

A12--4-15 inches, dark gray (10YR 4/1) silt loam, very dark-brown (10YR 2/2) moist; weak medium and coarse subangular blocky structure breaking to weak medium subangular blocks; soft, friable; noncalcareous; clear smooth boundary.

A13--15-22 inches, dark grayish-brown (10YR 4/2) silt loam, very dark-brown (10YR 2/2) moist; soft, very friable; noncalcareous; clear wavy boundary.

A'2--22-30 inches, pale-brown (10YR 6/3) clay loam, dark-brown (10YR 4/3) moist; moderate medium prismatic structures breaking to moderate medium and fine subangular blocks; slightly hard, friable; noncalcareous; about 35 percent of this horizon is very dark-brown material (10YR 2/2); clear wavy boundary.

A'B'--30-37 inches, pale-brown (10YR 6/3) clay loam, dark-brown (10YR 4/3) moist; moderate medium prismatic structure breaking to moderate medium subangular blocks; hard, friable; noncalcareous; 50 percent of this horizon is an A2 coat; clear wavy boundary.

B'A'--37-45 inches, pale-brown (10YR 6/3) clay loam, dark-brown (10YR 4/3) moist; moderate to strong medium prismatic structure breaking to moderate strong medium subangular blocks; hard, firm; noncalcareous; thick continuous clay film; 40 percent of this horizon is an A2 coat; clear wavy boundary.

B'21t--45-56 inches, pale-brown (10YR 6/3) clay loam, dark-brown (10YR 4/3) moist; strong medium prismatic to strong medium subangular blocky structure; hard, firm; noncalcareous; thick continuous clay films; abrupt wavy boundary.

B'22t--56-60 inches, very pale-brown (10YR 6/3) clay loam (10YR 4/3) moist; moderate to strong medium prismatic structure breaking to moderate to strong medium subangular blocks; soft, friable; noncalcareous; thick continuous clay film.

Thickness of the A1 horizon is 16-30 inches. The B'2t is 40-60 inches thick and a clay loam to clay in texture. Hues vary from 7.5YR to 10YR in the B'2t horizon.

Splitro Series

Location of the typical profile is not known.

A1--0-9 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine granular structure; soft, very friable; clear smooth boundary.

AC--9-18 inches, dark grayish-brown (10YR 4/2) loam very dark-brown (10YR 2/2) moist; massive; soft, very friable; gradual boundary.

R--18-20 inches, light brownish-gray (10YR 6/2) moist; weathered sandstone.

Terrestrial Fauna

[illegible] Series

[illegible] of the [illegible] profile to [illegible] [illegible].

B2 [illegible] [illegible], [illegible] (10YR 4/2) [illegible] [illegible] (10YR [illegible]) [illegible], [illegible] [illegible] [illegible] [illegible] [illegible], very friable, [illegible] [illegible] [illegible].

C [illegible] [illegible], [illegible] [illegible] (10YR 6/3) [illegible] very [illegible] [illegible] [illegible] [illegible] [illegible] soft, very friable gravel [illegible].

[illegible] [illegible] [illegible] [illegible] (10YR 6/3) [illegible], [illegible] [illegible].

APPENDIX D

TABLE OF CONTENTS
FOR
TERRESTRIAL FAUNA

Table	Title	Page
VIII-1	Terrestrial Fauna Species List------------------------------	VIII-1
VIII-2	Browse Plant Condition, Colowyo Mine, 1975-----------------	VIII-35

APPENDIX D

TABLE OF CONTENTS
FOR
TERRESTRIAL FAUNA

Figure	Title	Page
VIII-1	Big Game Management Units------------------------------------	VIII-36

Terrestrial Fauna

TABLE VIII-1
Species Known or Believed to Inhabit the Impact Region

Legend

1) SPECIES STATUS
   - ** On federal threatened species list
   - * On Colorado endangered species list
   - X On Audubon Society "Blue list"

2) SEASON OF USE

   First Column
   - Y - Yearlong
   - M - Fall and Spring migration
   - S - Summer
   - W - Winter
   - U - Undetermined

   Second Column
   - C - Common
   - UC - Uncommon
   - R - Rare
   - U - Undetermined

3) REGIONAL OCCURRENCE
   - E - Energy Fuels
   - G - W. R. Grace
   - P - Peabody
   - W - Western Mines
   - R - W. R. Grace Railroad

4) HABITAT TYPES*

   Vegetation
   - 1 - Grasslands
   - 4 - Sagebrush
   - 5 - Mountain shrub (oak, serviceberry, etc)
   - 6 - Conifer (except pinyon-juniper)
   - 7 - Barren (rocky, boulder strewn intermixed with grass and shrubs)
   - 9 - Pinyon - Juniper
   - 10a - Aspen
   - 13 - Greasewood
   - 14 - Saltbush
   - 19 - Croplands
   - 20 - Riparian

   Aquatic
   - 1 - Seasonally flooded basins or flats
   - 2 - Rivers and streams
   - 3 - Shallow fresh marsh (as much as six inches of water)
   - 4 - Deep fresh marsh (six inches to three feet of water)
   - 5 - Open fresh water (over three feet of water)

* Habitat used X
Preferred or critical habitat #

S P E C I E S 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE		HABITAT TYPES 4/																REMARKS
					VEGETATION											AQUATIC					
					1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
MAMMALS																					
Masked shrew (Sorex cinereus)	Y	U	E					X							#	#		X			
Vagrant shrew (Sorex vagrans)	Y	C	E	P				X			X				#	#		X			Vary greatly from year to year
Merriam's shrew (Sorex merriami)	Y	UC	E	P	X	X	X			X											
Little brown bat (Myotis lucifugus)	M-S	U	E				X	#		X	X				#						
Yuma Myotis (Myotis yumanensis)	M-S	U								X		#	#								
Long-eared Myotis (Myotis evotis)	M-S	U	E					X		X		X	#		#						
Long-legged Myotis (Myotis volans)	M-S	U	E				#	X		X	X				#						
Small-footed Myotis (Myotis leibii)	Y	U	E		X		X								X	X		X			
Silver-haired bat (Lasionycteris noctivagans)	M-S	U	E					X		X	X				#						
Big Brown bat (Eptesicus fuscus)	Y	U	E				X	X		X	X				X						

SPECIES[1/] WILD FAUNA	SEASON[2/] OF USE		REGIONAL OCCURRENCE[3/]	HABITAT TYPES[4/]																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Hoary Bat (*Lasiurus cinereus*)	M-S	UC	E				X		X	X				X						
Western big-eared bat (*Plecotus townsendii*)	Y	U	E			#	X		X											
Pallid bat (*Antrozous pallidus*)	M-S	U	E					#	X		X	X								
Nuttall's cottontail (*Sylvilagus nuttallii*)	Y	C	E P W		X	X	#		#	#			X	#						Population numbers variable with year for all lagomorphs listed below
Desert cottontail (*Sylvilagus audubonii*)	Y	UC	E G W	X	X	#					#	#								
Snowshoe hare (*Lepus americanus*)	Y	C	E P W				X			#										
Black-tailed jackrabbit (*Lepus californicus*)	U	U	G	X		X			X		#	#	#							
White-tailed jackrabbit (*Lepus townsendii*)	Y	C	E G P W	X	#	X	X		X	X	#	#	#	X						
Cliff chipmunk (*Eutamias dorsalis*)	Y	UC				X		#	X											Only in northwestern portion of region
Least chipmunk (*Eutamias minimus*)	Y	UC	E G P		X	X	X		X	X	X	X		X						

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Colorado chipmunk (Eutamias quadrivittatus)	Y	U	G W R			X	X	#	X											Only in western portion of region
Unita chipmunk (Eutamias umbrinus)	Y	U	E				#													
Yellow-bellied marmot (Marmota flaviventris)	Y	C	E G P W R			X	X	#		X				X						
White-tailed antelope squirrel (Ammospermophilus leucurus)	Y	R	R			X			X		X	X								
Richardson's ground squirrel (Spermophilus richardsonii)	Y	C	E G P W R	#	#															
Thirteen-lined ground squirrel (Spermophilus tridecemlineatus)	Y	C	E P R	#	X	X			X											
Golden-mantled ground squirrel (Spermophilus lateralis)	Y	C	E G P W		X	X	#	X	#	#				X						
Rock squirrel (Spermophilus variegatus)	U	U	R			X		#	X											

SPECIES[1/] WILD FAUNA	SEASON[2/] OF USE		REGIONAL OCCURRENCE[3/]					HABITAT TYPES[4/]																REMARKS
								VEGETATION											AQUATIC					
								1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
White-tailed prairie dog (*Cynomys leucurus*)	Y	C	E				R	#	X						X	X								
Red squirrel (*Tamiasciurus hudsonicus*)	Y	C	E		P						#		X											
Northern pocket gopher (*Thomomys talpoides*)	Y	C	E		P	W		X	X	X	X		X	X			X	X						
Olive-backed pocket mouse (*Perognathus fasciatus*)	Y	UC						X		X														Only in north-western portion of region
Ord's kangaroo rat (*Dipodomys ordii*)	Y	C	E					X	X						#	#								Sandy soils on central portion of region
Beaver (*Castor canadensis*)	Y	C	E	G	P		R											#		#	X	#		
Western harvest mouse (*Reithrodontomys megalotis*)	Y	UC						X										#	#					Only in western portion of region
Canyon mouse (*Peromyscus crinitus*)	Y	U								X		#	X											
Deer mouse (*Peromyscus maniculatus*)	Y	C	E	G	P	W	R	X	X	X	X	X	X	X	X	X	X	X						Most numerous mammal in region
Pinon mouse (*Peromyscus truei*)	Y	C	E									X	#											

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Northern grasshopper mouse (Onychomys leucogaster)	Y	C		#	X						X	X								
Bushy-tailed woodrat (Neotoma cinerea)	Y	C	E P		X	X	X	#	X											
Gapper's redbacked vole (Clethrionomys gappari)	U	U	E P				#		X											
Montane vole (Microtus montanus)	Y	C	E G P W				X			X										Open meadows
Long-tailed vole (Microtus longicaudus)	Y	U	E P W		X		X			X				#	#					
Sagebrush vole (Lagurus curtatus)	Y	UC	E P W	X	#															
Muskrat (Ondatra zibethicus)	Y	C	E G P R											X		#	X	X	X	
Western jumping mouse (Zapus princeps)	Y	C	E G P				X			X				#						Willow bottoms
Porcupine (Erethizon dorsatum)	Y	C	E G P W R		X	X	#	X	X	X	X	X		#						

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Coyote (Canis latrans)	Y	C	E G P W R	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Red fox (Vulpes fulva)	Y	C	E P W				X						X	#	X		X			
Gray fox (Urocyon cinereoargenteus)	Y	C	G R	X		#			X		X	X								
Ringtail (Bassariscus astutus)	Y	R				X			X					#						
Raccoon (Procyon lotor)	Y	C	E G P W R											#	X	X	X	X		
Black bear (Ursus americanus)	Y	C	E P W R			X	#		X	X				X						
Black-footed ferret ** (Mustela nigripes) *	Y	R	E	#	X						X	X								
Short-tailed weasel (Mustela erminea)	Y	U	E G P R				X			X										
Mink (Mustela vison)	Y	R	E P R											#		X				
Long-tailed weasel (Mustela frenata)	Y	C	E G P W R	X	X	X	X	X	X	X	X	X	X	X						

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Badger (Taxidea taxus)	Y	C	E P W	X	X	X	X		X	X	X	X	X	X						
Spotted skunk (Spilogale putorius)	Y	UC	E G R			X			X		X	X	X	#	X					
Striped skunk (Mephitis mephitis)	Y	C	E G P W R	X	X	X	X	X	X	X	X	X	X	#	X					
River otter (Lutra canadensis) *	Y	U	E											X		#				
Cougar (Felis concolor)	Y	C	E W R			X	#	#	X	X				X						
Bobcat (Lynx rufus)	Y	C	E G P W R		X	X	X		X	X	X	X	X	#	X					
Elk (Cervus canadensis)	Y	C	E G P W R	X	X	#	X			#		X	#	X	X					
Moose (Alces alces)	U	R																		Only known as wandering individuals
Mule deer (Odocoileus hemionus)	Y	C	E G P W R	X	X	#	X		X	X	X	X	X	X	X					
White-tailed deer (Odocoileus virginianus)	U	U	E P																	Few recorded sightings

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Pronghorn (Antilocapra americana)	Y	C	R	#	#						X	X								
Bighorn sheep (Ovis candensis)	Y	R				#			X	X										

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/				HABITAT TYPES 4/																REMARKS
							VEGETATION											AQUATIC					
							1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
BIRDS																							
Common loon (*Gavia immer*)	M	R	E			R															X	#	
Eared grebe (*Podiceps nigricollis*)	M	C	E		P	R															X	#	Possible nester
Horned grebe (*Podiceps auritus*)	M	U				R												X		X	X	X	Probable in region
Western grebe (*Aechmophorus occidentalis*) X	M	R	E		P	R												X		X	#	X	Possible nester
Pied-billed grebe (*Podilymbus podiceps*)	M	UC	E			R												X	X	X	X	X	
Great blue heron (*Ardea herodias*)	S	C	E	G	P	R											X	X	#	#	X		
Little blue heron (*Florida caerulea*)	S	U																	#				Possible resident
Snowy egret (*Egretta thula*)	S	C	E			R												X	X	X	X		
Black-crowned night heron X (*Nycticorax nycticorax*)	S	UC	E			R													X	X	X		
White faced ibis (*Plegadis chihi*) X	M	R	E			R												X		X	X		

SPECIES[1/] WILD FAUNA	SEASON[2/] OF USE		REGIONAL[3/] OCCURRENCE	HABITAT TYPES[4/]																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Whistling swan (Olor columbianus)	M	UC	E R													X			X	
Canada goose (Branta canadensis)	M-S	C	E G P R										X	X	X	X	X	X	X	Known nester
White-fronted goose (Aser albifrons)	M	R	E R										X	X	X	X	X	X	X	
Snow goose (Chen caerulescens)	M	R	E R										X	X	X	X	X	X	X	
Mallard (Anas platyrhynchos)	Y	C	E G P R										X	X	X	X	X	X	X	Known nester
Gadwall (Anas strepera)	M	C	E G R										X	X	X	X	X	X	X	
Pintail (Anas acuta)	M-S	C	E G P R										X	X	X	X	X	X	X	Known nester
Cinnamon teal (Anas cyanoptera)	M-S	C	E G P R											X	X	X	X	X		Known nester
Green-winged teal (Anas crecca)	M-S	C	E . G P R											X	X	X	X	X	X	Known nester
Blue-winged teal (Anas discors)	M-S	C	E G P R											X	X	X	X	X		Known nester

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
American widgeon (Mareca americana)	M	C	E G R										X	X	X	X	X	X	X	Known nester
Shoveller (Anas clypeata)	M	C	E R										X	X	X	X	X	X	X	
Redhead (Aythya americana)	M	UC	E G P R													X		X	X	Known nester
Ring-neck duck (Aythya collaris)	M	UC	E R													X		X	X	
Canvasback (Aythya valisineria)	M	UC	E G R													X		X	X	
Greater scaup (Aythya marila)	M	R	G R													X		X	X	
Lesser scaup (Aythya affinis)	M	C	E G P R													X		X	X	
Common goldeneye (Bucephala clangula)	M-W	C	E R													X		X	X	
Barrows goldeneye (Bucephala islandica)	W	R	R													X	X	X	X	
Bufflehead (Bucephala albeola)	M	UC	E R													X	X	X	X	

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Ruddy duck (Oxyura jamaicensis)	M-S	C	E G R												X	X	X	X	X	
Hooded merganser (Lophodytes cucullatus)	W	U	E G R													X		X	X	Probable in region
Common merganser (Mergus merganser)	W	C	E G P R													X	X	X	X	
Red-breasted merganser (Mergus serrator)	W	UC	R													X		X	X	
Turkey vulture (Cathartes aura)	S	C	E G P W R	X	X	X	X	X	X	X	X	X	X	#						Known nester
Goshawk (Accipter gentilis)	W-S	R	E P R				#		X											Known nester
Sharp-shinned hawk (Accipter striatus)[X]	W-S	C	E P R				#		X					X						
Cooper's hawk (Accipter cooperii)[X]	W-S	C	E G P R			X	X		X	X				#						Known nester
Swainson's hawk (Buteo swainsoni)[X]	M-S	C	E P R	X	X	X	X	X	X	X	X	X	X	X	X					Probable nester
Rough-legged hawk (Buteo lagopus)	W	C	E P R	#	X	X		X			X	X	X	X	X		X			

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE					HABITAT TYPES 4/																REMARKS
								VEGETATION											AQUATIC					
								1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Red-tailed hawk (Buteo jamaicensis)	Y	C	E	G	P	W	R	X	X	X	X	X	X	X	X	X	X	X	X					Known nester
Ferruginous hawk (Buteo regalis) X	W	UC	E		P		R	#	X	X		X			X	X	X	X	X					Historically a nester
Golden eagle (Aquila chrysaetos)	Y	C	E	G	P	W	R	X	X	X	X	X	X	X	X	X	X	X	X					Known nester
Bald eagle (Haliaectus leucocephalus)	W	UC	E	G	P	W	R	X	X						X	X		#		X	X	X	X	
Marsh hawk (Circus cyaneus) X	W-S	UC	E	G	P		R	#	X	X		X		X	X	X	X	X	#		#			
Prairie falcon (Falco mexicanus) X	Y	R	E	G	P		R	#	X	X		X			X	X	X	X	X					
Pigeon hawk (Falco columbarius)	W	R	E		P		R			X	X		X	X			X	X						
American kestrel (Falco sparverius) X	S	C	E	G	P	W	R	#	X	X		X		X	X	X	#	#	X					Known nester
Peregrine falcon ** (Falco peregrinus) *	M	R	E	G			R	#	X	X		X			X	X	X	#	X		X	X	X	
Blue grouse (Dendragapus obscurus)	Y	C	E	G	P		R				#		X	#				X						Known nester

S P E C I E S 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/				HABITAT TYPES 4/																REMARKS
							VEGETATION											AQUATIC					
							1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Ruffed grouse (Bonasa umbellus)	U	C											#										Reported north of Din. Nat. Monument
Sharp-tailed grouse (Pedioecetes phasianellus)	Y	C	E		P	R	#		X							#	X	X					Known nesters
Sage grouse (Centrocercus urophasianus)X	Y	C	E	G	P	R		#															Known nester
Ring-necked pheasant (Phasianus colchicus)	Y	UC														#	X						Known nester
Chukar (Alectoris chukar)	U	U		G		R	X				#												Birds not responding well in most release sites
Gray partridge (Perdix perdix)	U	U														#							Birds released but no population information
Greater sandhill crane (Grus canadensis tabida)*	S	UC				R	X									#	#	X	X		X		Known nesters
Virginia rail (Rallus limicola)	S	U	E			R														X	X		
Sora (Porzana carolina)	S	UC	E		P	R														X	X		
American coot (Fulica americana)	M-S	UC		G		R													X	X	X		

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/ VEGETATION 1	4	5	6	7	9	10a	13	14	19	20	AQUATIC 1	2	3	4	5	REMARKS
Semipalmated plover (*Charadrius semipalmatus*)	M	U	R													X	X			Possible in region
Killdeer (*Charadrius vociferus*)	M-S	C	E G P R										X		X	X	X			
Common snipe (*Capella gallinago*)	M-S	C	E G P R	X									X	X	#	X	#			
Long-billed curlew (*Numenius americanus*)	M-S	U	E R	X									X	X	X	X	X			Possible in region
Spotted sandpiper (*Actitis macularia*)	S	C	E P R											X		X	X			
Solitary sandpiper (*Tringa solitaria*)	M	C	E G R											X		X	X	X		
Greater yellowlegs (*Totanus melanoleucus*)	M	C	E R													X	#	X		
Lesser yellowlegs (*Totanus flavipes*)	M	UC	E R													X	#	X		
Baird's sandpiper (*Calidris bairdii*)	M	U	R											X	X	X	X			Probably fairly common
Least sandpiper (*Calidris minutilla*)	M	C	E R											X	X	X	X			

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/	HABITAT TYPES 4/																	REMARKS
				VEGETATION											AQUATIC						
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5		
Willet (Catoptrophorus semipalmatus)	M	UC	E R												X	X	X				May nest
Long-bill dowitcher (Limnodromus scolopaceus)	M	U	E P R												X	X	X				
Western sandpiper (Calidris mauri)	M	UC	E R												X	X	X				
American avocet (Recurvirostra americana)	M	U	E R												X	X	#	X			
Black-necked stilt (Himantopus mexicanus)	U	U	R												X	X	#	X			
Wilson's phalarope (Steganopus tricolor)	M	C	E G P R												X	X	X	#	X		
Northern phalarope (Lobipes lobatus)	M	UC	R												X	X	X	#	X		
Herring gull (Larus argentatus)	M	UC	E R										X	X		X	X	X	#		
California gull (Larus californicus)	M	R	P R										X	X		X	X	X	#		
Ring-billed gull (Larus delawarensis)	M	UC	E P R										X	X		X	X	X	#		
Forster's tern (Sterna forsteri)	M	U	E R													X	X	X	#		

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Black tern (*Chlidonias niger*)	M	U	E R												X	X	X	#	#	
Band-tailed pidgeon (*Columba fasciata*)	M-S	UC	E R				#													Higher mountainous elevations
Rock dove (*Columba livia*)	U	U	E G R			X	X	X	X	X			X	X						In and around areas of human habitation
Mourning dove (*Zenaida macroura*)	M-S	C	E G P W R	X		X			X	X		X	X	X						
Yellow-billed cuckoo (*Coccyzus americanus*)	M-S	U	E R				X		X					#						
Screech owl (*Otus asio*)	U	UC	E P R				X			X			#	#						
Barn owl (*Tyto alba*)X	U	U	E										#	#						
Great horned owl (*Bubo virginianus*)	Y	C	E P W R			X	X		X	X			X	#						Known nesters
Burrowing owl (*Speotyto cunicularia*)X	S	C	E R	#	X			X			X	X								Known nesters
Long-eared owl (*Asio otus*)	Y	U	E R				X		X	X				#						

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Short-eared owl (Asio flammeus)	W	UC	E R	#									X	X	X		#			
Saw-whet owl (Aegolius acadicus)	Y	UC	E P R				#		X					X						
Poor-will (Phalaenoptilus nuttallii)	S	C	E P	X	X	X			X		X	X	X	X						
Common nighthawk (Chordeiles minor) X	S	C	E G P R	#	X	X					X	X	X	X						Known nester
White-throated swift (Aeronautes saxatalis)	S	C	E G P R					#												Known nester on sheer cliffs
Black-chinned hummingbird (Archilochus alexandri)	S	C	E G R				X		X					#						
Broad-tailed hummingbird (Selasphorus platycercus)	S	C	E P R			X	X		X	X				#						High mountain meadows
Rufous hummingbird (Selasphorus rufus)	S	C	E G R				X							#						
Belted kingfisher (Megaceryle alcyon)	S	UC	E G P R											X		X		X		
Common flicker (Colaptes auratus)	Y	C	E G P R			X	X		X	X				#						

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE				HABITAT TYPES 4/																REMARKS
							VEGETATION											AQUATIC					
							1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Lewis' woodpecker (Asynodesmus lewis)X	Y	UC	E		P	R				#		X	X				#						
Redheaded woodpecker (Melanerpes erythrocephalus)	U	R	E														#						Accidental
Yellow-bellied sapsucker (Sphyrapicus varius)	S	C	E		P	R							#										
Williamson's sapsucker (Sphyrapicus thyroideus)	S	C	E			R				#		X											
Hairy woodpecker (Dendrocopos villosus) X	Y	UC	E		P	R				#		X	X				#						
Downy woodpecker (Dendrocopos pubescens)	Y	UC	E		P	R				X		X	X				#						
Eastern kingbird (Tyrannus tyrannus)	S	UC	E			R										#	#	X	X	X			
Western kingbird (Tyrannus verticalis)	S	C	E	G	P	R	X								X	#	#	X	X	X			
Cassin's kingbird (Tyrannus vociferans)	S	UC				R			#	X							X						
Ash-throated flycatcher (Myiarchus cinerascens)	S	C	E	G		R			X			X			X	X							

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE				HABITAT TYPES 4/																REMARKS
							VEGETATION											AQUATIC					
							1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Say's phoebe (Sayornis saya)	S	C		G	P	R	X	X	X		X	X		X	X	X	X						Commonly associated with Bluffs
Willow flycatcher (Empidonax traillii)	S	UC	E		P	R											#	X	X	X			Most often in willow bottoms
Hammond's flycatcher (Empidonax hammondii)	M-S	UC			P	R						#											
Dusky flycatcher (Empidonax oberholseri)	S	U	E		P	R			X	X		X	X				X						
Gray flycatcher (Empidonax wrightii)	S	U	E			R		X	X			X											
Western flycatcher (Empidonax difficilis)	S	C	E	G	P	R				#							X						
Western wood peewee (Contopus sordidulus)	S	C	E	G	P	R				#		X	X				#						
Horned lark (Eremophila alpestris)	Y	C	E	G	P	R	#	X			X			X	X	X							
Violet-green swallow (Tachycineta thalassina)	S	C	E	G	P	R	X	X	X	X		X					X	X	X	X	X		
Tree swallow (Iridoprocne bicolor)	M-S	C	E		P	R	X	X	X								X	X	X	X	X		

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Bank swallow (Riparia riparia)	M-S	UC	E R	X										#	X	X	X			
Rough-winged swallow (Stelgidopteryx ruficollis)	M-S	UC	E P R											#	X	X	X	X		
Barn swallow (Hirundo rustica)	M-S	C	E G P R	X									#	#	X	X				Often associated with human habitation
Cliff swallow (Petrochelidon pyrrhonota)	S	C	E G P R	X			X	#	X	X				#	X	X	X	X		Nests on rocky cliffs
Stellar's jay (Cyanocitta stelleri)	Y	C	E G P W R			X	#		X	X				X						
Scrub jay (Aphelocoma coerulescens)	Y	C	E G P R		X	X			#					X						
Pinyon jay (Gymnothinus cyanocephalus)	Y	C	G R						#											
Black-billed magpie (Pica pica)	Y	C	E G P W R		X	X			X		X	X	X	X						
Clark's nutcracker (Nucifraga columbiana)	Y	C	E G R				#													
Common raven (Corvus corax)	Y	C	E P R		X	X	X				X	X	#	#						

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Common crow (Corvus brachyrhynchos)	Y	UC	E P W							X			#	X						
Black-capped chickadee (Parus atricapillus)	Y	UC	E P R			X	X		#	X				#						Known nester in pinyon
Mountain chickadee (Parus gambeli)	Y	C	E G P R			X	#		X	X										
Plain titmouse (Parus inornatus)	Y	C	E R			X	X		X	X				X						
Bushtit (Psaltriparus minimus)	Y	C	E R			X			X	X				X						
White-breasted nuthatch (Sitta carolinensis)	Y	UC	E R				X							#						
Grown creeper (Certhia familiaris)	Y	UC	E R				#													
Dipper (Cinclus mexicanus)	Y	C	E R													#				
House wren (Troglodytes aedon)	S	C	E. P R			X	X		X					X						
Bewick's wren (Thryomanes bewickii) X	S	C	E R			X			#											Known nester

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Canyon wren (Salpinctes mexicanus)	S	UC	E P R	X	X	#		#												
Rock wren (Salpinctes obsoletus)	S	C	E G P R	X	X			#			X	X								Known nester
Catbird (Dumetella carolinensis)	U	U	E P R			#														
Sage thrasher (Oceoscoptes montanus)	S	C	E G P R		X	#					X	X								
Robin (Turdus migratorius)	M-S	C	E G P R		X	X			X	X	X	X	X	X	X		X			
Townsend's solitaire (Myadestes townsendi)	Y	UC	E R				X		X	X				X						
Hermit thrush (Catharus guttatus)	S	C	E P R				X		X	X										
Swainson's thrush (Catharus ustulatus)	M	UC	E R				X			X				#						
Veery (Catharus fuscescens)	S	UC	E R							X				#						
Mountain bluebird (Sialia currucoides) X	M	C	E G P R			X	X	X	X	X				X						Known nester

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE			HABITAT TYPES 4/																REMARKS
						VEGETATION											AQUATIC					
						1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Blue-gray gnatcatcher (Polioptila caerulea)	S	C	E	P	R		X	X			X					#						
Ruby-crowned kinglet (Regulus calendula)	M-S	C	E	P	R				X		X											
Bohemian waxwing (Bombycilla garrulus)	W	U	E	P	R			X								#						Irregular appearance
Cedar waxwing (Bombycilla cedrorum)	W	U	E	P	R			X								#						Irregular appearance
Northern shrike (Lanius excubitor)	W	UC	E	P	R	#	X		X	X			X	X	X	X						
Loggerhead shrike (Lanius ludovicianus) X	S	UC	E	P	R	#	X		X	X			X	#	X	X						
Starling (Sturnus vulgaris)	Y	C	E	P											X	X						Common aroun towns and farms
Red-eyed vireo (Vireo olivaceus)	U	U		P	R																	Possible summ visitor
Solitary vireo (Vireo solitarius)	S	C	E	P	R			X	X		X	X				X						
Warbling vireo (Vireo gilvus)	S	C	E	P	R			X				X				X						Known nester

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/			HABITAT TYPES 4/																REMARKS
						VEGETATION											AQUATIC					
						1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Orange-crowned warbler (Vermivora celata)	M	UC	E	P	R			X				X				X						
Virginia's warbler (Vermivora virginiae)	S	C	E	P	R			X			X											
Yellow warbler (Dendroica petechia)	S	C	E	P	R											#						
Yellow rumped warbler (Dendroica coronata)	S	C	E	P	R				X		X	X				#						
Black-throated gray warbler (Dendroica nigrescens)	S	C	E		R		X	X			X	X	X	X								
Townsend's warbler (Dendroica townsendi)	M	UC	E		R				#													
Northern waterthrush (Seiurus noveboracensis)	M	R	E													#						
Mac Gillivray's warbler (Oporornis tolmiei)	M	UC	E	P	R		X	X								X						
Yellowthroat (Geothlypis trichas)	S	UC	E		R											X	X	X	#			
Yellow-breasted chat (Ieteria virens)	S	C	E	P	R											#	X	X	X			

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/		HABITAT TYPES 4/																REMARKS
					VEGETATION											AQUATIC					
					1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Wilsons warbler (*Wilsonia pusilla*)	S	C	E	R											#						
American redstart (*Setophaga ruticilla*)	S	U		R											#						
House sparrow (*Passer domesticus*)	Y	C	E G	R																	Most common in areas of human habitation
Bobolink (*Dolichonyx oryzivorus*)	S	R	E	R	X									X	X	X		X	X		
Western meadowlark (*Sturnella neglecta*)	S-Y	C	E G P	R	#								X	X							
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	S	C	E G	R												X	X	#	X		Cattail marshes
Red-winged blackbird (*Agelaius phoeniceus*)	S-Y	C	E G P	R	X									#	X	X		#	X		
Brewers blackbird (*Euphagus cyanocephalus*)	Y	C	E G P	R	X									X	X						Most common in areas of human habitation
Brown-headed cowbird (*Molothrus ater*)	S	C	E G P	R	X		X			X	X			X	X						
Common grackle (*Quiscalus quiscalus*)	U	U	E											X	X	X					

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL OCCURRENCE 3/				HABITAT TYPES 4/																REMARKS
							VEGETATION											AQUATIC					
							1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Northern oriole (Icterus galbula)	S	C	E		P	R							X				X	X					Also areas of human habitation
Western tanager (Piranga ludoviciana)	M	C	E	G	P	R			X	#		X	X										
Black-headed grosbeak (Pheucticus melanocephalus)	S	C	E	G	P	R			X	X		X	X				X						
Indigo bunting (Passerina cyanea)	U	U				R			#					X	X		X						
Lazuli bunting (Passerina amoena)	S	C	E		P	R		X	X				X	X	X		X						Especially in Riparian
Evening grosbeak (Hesperiphona vespertina)	Y	UC	E							#							X						
Cassins finch (Carpodacus cassinii)	Y	C	E		P	R				#		X	X										
House finch (Carpodacus mexicanus)	Y	C	E	G	P	R		X	#			X		X	X	X	#						Common in areas of human habitation
Pine grosbeak (Pinicola enucleator)	Y	UC	E		P	R			X	#		X											
Gray-crowned rosy finch (Leucosticte tephrocotis)	W	U	E			R			X	X	#	X											

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE				HABITAT TYPES 4/																REMARKS
							VEGETATION											AQUATIC					
							1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Black rosy finch (Leucosticte altrata)	W	C	E			R			X	X	#	X											
Brown-capped rosy finch (Leucosticte australis)	W	UC	E			R			X	X	#	X											
Pine siskin (Spinus pinus)	W	C	E		P	R				#		X	X				X						
American goldfinch (Spinus tristis)	Y	C	E	G	P	R			X				X				#						
Lesser goldfinch (Spinus psaltris)	S	UC	E		P	R			X	X		X	X				X						
Red crossbill (Loxia curvirostra)	U	U	E		P	R				#													Irregular movements
Green-tailed towhee (Chlorura chlorura)	M-S	C	E		P	R		X	#			X		X	X								Known nester
Rufous-sided towhee (Pipilo erythrophthcalmus)	U	C	E		P	R		X	#			X			X		X						
Lark bunting (Calamospiza melanocorys)	S	UC	E			R	X				X			X	X								
Savannah sparrow (Passerculus sandwishensis)	M	UC	E			R	X										X			X			

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE				HABITAT TYPES 4/ VEGETATION 1	4	5	6	7	9	10a	13	14	19	20	AQUATIC 1	2	3	4	5	REMARKS
Vesper sparrow (Pooecetes gramineus)	S	C	E		P	R	X	#						X	X		X						
Lark sparrow (Chondestes grammacus)	S	C	E		P	R		X	X					X	X	X							
Sage sparrow (Amphispiza belli)	S	C	E	G		R		#	X					X	X								Known nester
Dark-eyed junco (Junco hyemalis)	W	C	E		P	R			X	#		X					X						
Gray-headed junco (Junco caniceps)	Y	C	E		P	R			X	#		X	X				X						
Tree sparrow (Spizella arborea)	W	UC	E			R	X	X	X					X	X		X						
Chipping sparrow (Spizella passerina)	S	C	E	G	P	R		X				X	X				X						
Brewer's sparrow (Spizella breweri)	S	C	E	G	P	R		#	X					X	X								
White-crowned sparrow (Zonotrichia leucophrys)	Y	C	E	G	P	R		X	X					X	X								
Lincoln's sparrow (Melospiza lincolnii)	S	C	E		P	R							X				X	X		X			

SPECIES 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE			HABITAT TYPES 4/																REMARKS
						VEGETATION											AQUATIC					
						1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Song sparrow (Melospiza melodia)	Y	C	E	P	R	X		X								X	X		X			Known nester
Fox sparrow (Passerella iliaca)	S	U	E		R							X				X	X		X			

S P E C I E S 1/ WILD FAUNA	SEASON 2/ OF USE		REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
				VEGETATION											AQUATIC					
				1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
AMPHIBIANS & REPTILES																				
Tiger salamander (Ambystoma tigrinum)	Y	U	E P R	X	X	X	X		X	X				X	X	X	X	X		
Western toad (Bufo boreas)	Y	U	E P R	X		X				X				X	X	X	X	X	X	
Woodhouse's toad (Bufo woodhousei)	Y	U	E	X	X						X	X		X	X	X	X			
Chorus frog (Pseudacris triseriata)	Y	U	E P R	X									X	#	#		X	X		
Leopard frog (Rana pipiens)	Y	U	E P R											X	#	#	X	X		
Collared Lizard (Crotaphytus collaris)	Y	U			X	X		#			X	X								
Eastern fence lizard (Sceloperus undulatus)	Y	U	E P R		X	X	X	X	X	X	X	X	X	X						
Sagebrush lizard (Sceloperus graciosus)	Y	U	E P		#	X	X		X					X						
Tree lizard (Urosausus ornatus)	Y	U	E R			X	X		X					X						
Side-blotched lizard (Uta stansburiana)	Y	U	E W R	X	X			X			X	X		X						

SPECIES[1/] WILD FAUNA	SEASON[2/] OF USE		REGIONAL OCCURRENCE[3/]				HABITAT TYPES[4/]																REMARKS
							VEGETATION											AQUATIC					
							1	4	5	6	7	9	10a	13	14	19	20	1	2	3	4	5	
Short-horned lizard (Phrynosoma douglassi)	Y	U	E			R	X	X	X	X	X	X											
Western whiptail (Cnemidophorus tigris)	Y	U	E									X		X	X		X						
Striped whipsnake (Masticophis taeniates)	Y	U	E			R	X	X	X	X		X		X	X	X	X						
Smooth green snake (Opheodrys vernalis)	Y	U	E	P			X				X						#						
Gopher snake (Pituophis melanoleucus)	Y	U	E			R	X	X	X	X		X	X	X	X	X	X						
Milk snake (Lampropeltis triangulum)	Y	U	E							X	X	X				X	X						
Western terrestrial garter snake (Thamnophis elegans)	Y	U	E	P	W	R	X	X	X	X		X		X	X		X						
Western rattlesnake (Crotalus viridis)	Y	U	E	P	W	R	X		X	X	#	X					X						

SPECIES 1/	SEASON 2/ OF USE	REGIONAL 3/ OCCURRENCE	HABITAT TYPES 4/																REMARKS
			VEGETATION											AQUATIC					
DOMESTIC FAUNA			1	4	5	6	7	9	10 a	13	14	19	20	1	2	3	4	5	
Horse (Equus sp.)																			
Cow (Bos sp.)																			
Sheep (Ovis sp.)																			
Cats (Felis domesticus)																			
Dogs (Canis familiaris)																			

Terrestrial Fauna

TABLE VIII-2

Browse Plant Condition, Colowyo Mine, 1975

Transect	Production Index	Growth Index	Use Index	Utilization
#1 Oak	3.6	3.5	46.4	11.9
#1 Big Sage	6.6	6.6	9.9	1.5
#1 Bitterbrush	No use			
#1 Serviceberry	3.9	3.3	30.4	7.8
#1 Snowberry	No use (snow covered)			
#2 Oak	5.7	4.9	83.8	14.7
#2 Big Sage	5.0	5.0	17.0	3.4
#2 Serviceberry	4.7	3.8	146.2	31.1

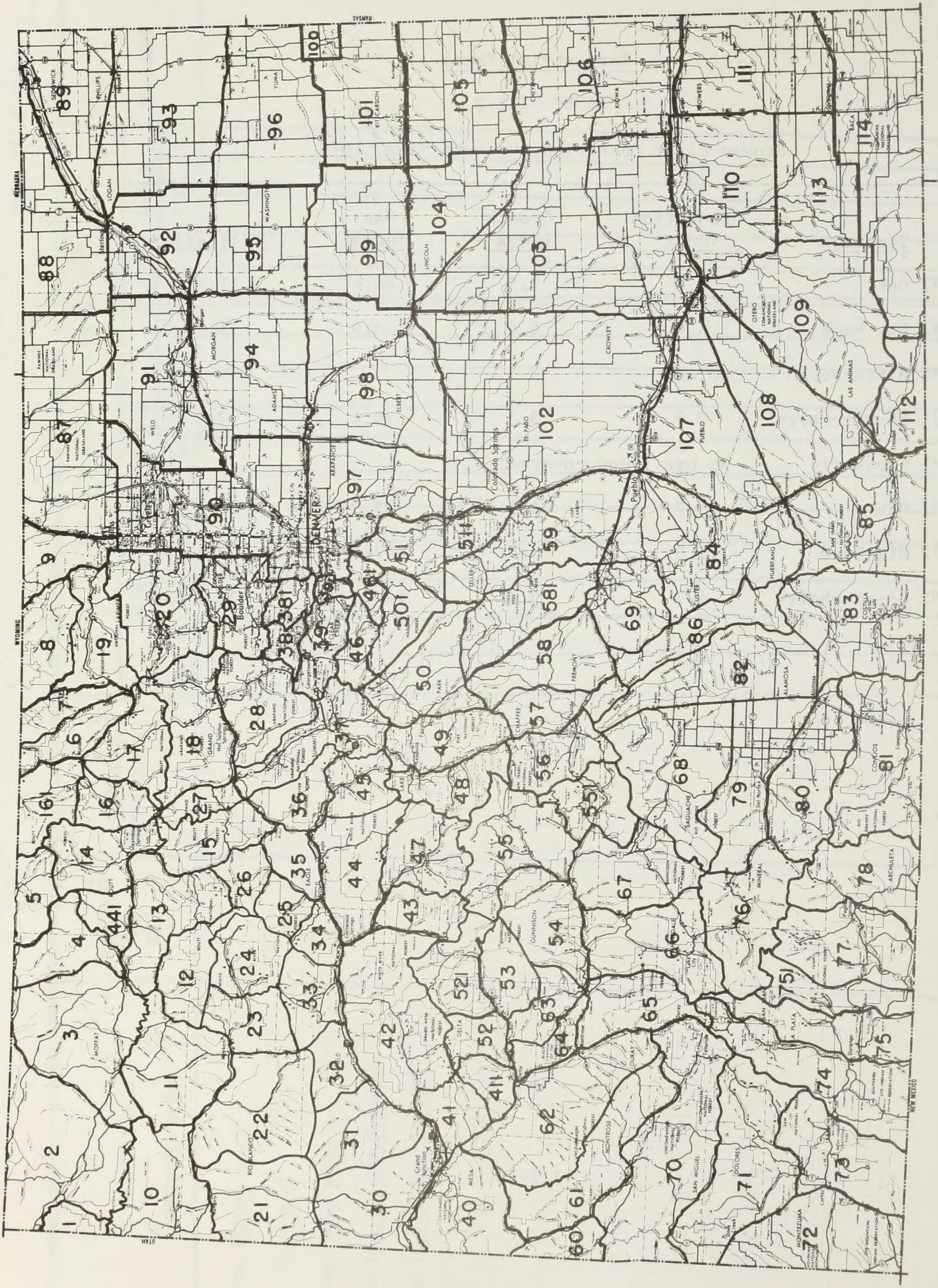


FIGURE VIII-1

Big Game Management Units.

Aquatic Biology

APPENDIX D

TABLE OF CONTENTS
FOR
AQUATIC BIOLOGY

Table	Title	Page
IX-1	Critical Habitat and Spawning Period Criteria for Fish Species Found in Study Region	IX-1-2
IX-2	Characteristics Pertinent to the Evaluation of Stream and Lake Fisheries in the Study Region	IX-3-5
IX-3	Chemical Analyses for Upper Dry Creek in March, April, and June 1974	IX-6
IX-4	Chemical Analyses for Northern Tributary to Dry Creek in May and June 1974	IX-7
IX-5	Chemical Analyses for Lower Dry Creek in March, April, and June 1974	IX-8
IX-6	Chemical Analyses for Upper Sage Creek in March, April, and June 1974	IX-9
IX-7	Chemical Analyses for Sage Creek Below Sage Creek Reservoir in April and June 1974	IX-10
IX-8	Chemical Analyses of Lower Sage Creek in March, April, and June 1974	IX-11
IX-9	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in Upper Dry Creek	IX-12
IX-10	Number and Relative Abundance (by order) of Benthic Animals Caught with a Surber Sampler in Upper Dry Creek	IX-13-14
IX-11	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in Hubberson Gulch near Confluence with Dry Creek	IX-15
IX-12	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in Lower Dry Creek	IX-16
IX-13	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in Upper Sage Creek	IX-17

Table	Title	Page
IX-14	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in Sage Creek Below Sage Creek Reservoir	IX-18
IX-15	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in Lower Sage Creek	IX-19
IX-16	Number and Relative Abundance (by order) of Benthic Animals Caught with a Surber Sampler in Grassy Creek	IX-20
IX-17	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in the "Mudslide" Lake in Section 15	IX-21
IX-18	Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-Net in the Uppermost Beaver Pond in Section 27	IX-22
IX-19	Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July, August, and September, 1975 at Each Station on Fish Creek	IX-23-26
IX-20	Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July, August, and September, 1975 at Each Station on Trout Creek	IX-27-29
IX-21	Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July and August, 1975 at Each Station on Foidel Creek	IX-30-32
IX-22	Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July, August, and September, 1975 at Each Station on Middle Creek	IX-33-36

Aquatic Biology

TABLE IX-1

Critical Habitat and Spawning Period Criteria for Fish Species Found in Study Region

Common Name	Scientific Name	Habitat Preferences	Spawning Period	Status of Species in Analysis Area 2/
Rainbow Trout	Salmo gairdneri	Water temperature of 50-60° F; can adapt to almost any coldwater environment; exhibit best growth in warmer, richer lakes and streams at lower elevations	Spring, April to June	Most abundant game fish in analysis area; frequently stocked in both lakes and streams by Colorado Division of Wildlife on an annual basis
Brook Trout	Salvelinus fontinalis	Water temperature of 55-66°F; mountain streams and lakes above 9,000 feet	Fall, generally October	Common; mainly in lakes and small, clear streams at high elevations
Cutthroat Trout	Salmo clarki	Prefer colder water than their near relative, the rainbow; typically found in headwaters of high mountain streams and in mountain lakes	Spring, April to June	Only trout native to Colorado; abundance has been greatly reduced; present, usually at higher elevations
Brown Trout	Salmo trutta	Most versatile of trouts; can adjust to almost any cold water habitat	Fall, normally October	Present, generally in larger streams and lakes at lower elevations
Mountain Whitefish	Prosopium williamsoni	Larger rivers with good pools, three or four feet deep with riffle areas and gravel bottoms	Fall	Present in larger drainages such as the Yampa and Elk Rivers
Longnose Sucker	Catostomus catostomus	High lakes, reservoirs and streams	Late Spring	Present in major drainages
White Sucker	Catostomus commersoni	Lakes and reservoirs; pools in streams where there is much cover from bank vegetation	Spring and early Summer	Abundant in reservoirs, lakes, and tributary streams
Colorado Squawfish 1/	Ptychocheilus lucius	Historically, larger streams in Colorado River Basin	Early Spring	Present in Yampa and White Rivers
Channel Catfish	Ictalurus punctatus	Warm water rivers and reservoirs	Late Spring or early Summer	Present in lower, warm reaches of larger streams and in warm water lakes
Carp	Cyprinus carpio	Warm shallow water with plenty of aquatic vegetation	Late May to early June	Present in Little Snake, Yampa, and White Rivers and Rio Blanco Lake

1/ Endangered Species

2/ Abundant = species is plentiful in analysis area
Common = species is found regularly in analysis area
Present = species is found occasionally in analysis area

TABLE IX-1 (Cont.)

Critical Habitat and Spawning Period Criteria for Fish Species Found in Study Region

Common Name	Scientific Name	Habitat Preferences	Spawning Period	Status of Species 2/ in Analysis Area
Bonytail Chub 1/	*Gila elegans*	Historically, larger streams in the Colorado River Basin	Late June to early July	Present in Yampa and White Rivers
Humpback Chub 1/	*Gila cypha*	Historically, canyon areas of large streams in the Colorado River Basin	Not known	Present in Yampa and White Rivers
Humpback Sucker 1/	*Xyrauchen texansus*	Historically, in slack waters of large rivers or impoundments Colorado River system	March to June	Present in Yampa and White Rivers
Mottled Sculpin	*Cottus bairdi*	Small mountain trout streams	Spring	Common in trout streams
Green Sunfish	*Lepomis cyanellus*	Warm water fisheries habitats	June to mid-August	Present in Axial Basin and Ralph White Reservoirs
Black Bullhead Catfish	*Ictalurus molas*	Warm water fisheries habitats	Late spring or early summer	Present in Axial Basin and Ralph White and Rio Blanco Reservoirs
Northern Pike	*Esox lucius*	Warm water lakes and reservoirs	Early spring	Present in Ralph White and Rio Blanco Reservoirs
Yellow Perch	*Perca flavescens*	Warm water fluctuating reservoirs	Spring	Present in Axial Basin Reservoir
Black Crappie	*Pomoxis nigromalulatus*	Clear, weedy lakes	Spring	Present in Axial Basin Reservoir
Largemouth Bass	*Micropterus salmoides*	Warm water, fluctuating, heavily vegetated reservoirs	Late May through June	Present in Axial Basin Reservoir
Kokanee Salmon	*Oncorhynchus nerka*	Large, fluctuating mountain reservoirs	Mid-October to late December	Present in Crosho Lake
Speckled Dace	*Rhinichthys osculus*	Small to moderate-sized swift streams	Spring?	Common in trout streams

1/ Endangered Species
2/ Abundant = species is plentiful in analysis area
Common = species is found regularly in analysis area
Present = species is found occasionally in analysis area

TABLE IX-2

Characteristics Pertinent to the Evaluation of Stream Fisheries in the Study Region

Stream Name	Drainage System Name	Value Rating*	Fish Species Present (Percent of Total Population)	Mean Stream Flow (cfs)	Mean Stream Width (Feet)	Populations Being Maintained By Stocking (Species)	Populations Being Maintained By Natural Reproduction (Species)	Overall Population Conditions
Routt County								
Bear C	Hot Springs-Elk	75	B(100)	2.0	3	No	Abundant (B)	Overpopulated (B)
Beaver C	SF Williams F	84	B(50), C(50)	1.5	4	Rarely	Some	Stable
Beaver C	Willow C	80	B(60), C(20), R(20)	10.0	5	Occasionally	Abundant (B)	Stable
Deep C	Elk R	55	B(10), C(10), R(70), W(10)	4.0	7	Rarely	Some	Stable
Egeria C	Rock C	72	B(1t), C(15), R(70)	E8.0	E4	Regularly	Some	Underpopulated
Elk R	Yampa R	73	B(5), Br(5), C(5), R(50) W(15), Rough(20)	500.0	50	Regularly	Some	Stable
Elkhead C	Yampa R	70	B(30), C(40), R(30)	NA	E11	Regularly	Some	Stable
Finger Rock C	Yampa R	73	B(50), Br(50)	E1.0	E2	No	Some	Stable
Fish C	Trout C	67	B(50), C(50)	3.0	6	No	Some	Stable
Hunt C	Yampa R	57	R(90), S(10)	E2.0	E3	Rarely	Some (s)	Underpopulated
Middle C	Trout C	50	B(50), R(50)	E2.0	E3	Occasionally	Some	Stable
Morrison C	Yampa R	40	B(100)	E2.0	E3	Regularly	Abundant (B)	Overpopulated (B)
Oak C	Yampa R	40	R(100)	2.0	4	Regularly	No	Stable
Second C	EF Williams F	50	R(100)	0.5	2	No	Some	Stable
Slater C	Little Snake R	85	B(30), Br(5), C(5), R(60)	20.0	15	Regularly	Some (B, Br, C)	Stable
Little Snake R	Yampa R	88	B(5), Br(10), C(5), R(80)	150.0	70	Regularly	Some	Stable
MF Snake R	Yampa R	83	B(30), R(70)	20.0	20	Regularly	Some (B)	Stable
SF Snake R	Yampa R	77	B(30), R(70)	8.0	10	No	Some	Stable
Soda C	Yampa R	48	B(100)	2.0	3	Regularly	Abundant (B)	Overpopulated (B)
Spring C	Yampa R	52	B(70), R(30)	0.5	3	Regularly	Abundant (B)	Overpopulated (B)
Tow C	Yampa R	73	C(100)	7.0	10	Occasionally	Some	Stable
Walton C	Yampa R	47	B(99), R(T)	E4.0	E5	Regularly	Abundant (B)	Overpopulated (B)
Williams Fork R	Yampa R	93	Br(10, C(10, R(80)	30.0	30	Regularly	Some (Br)	Stable
SF Williams F R	Yampa R	80	C(40), R(60)	E5.0	E10	Occasionally	Some	Stable
Willow C	Elk R	83	B(20), C(10), R(60), W(10)	E20.0	10	Regularly	Some	Stable
Yampa R	Service C to Bear R	40	Br(5), R(80), S(10), W(5)	NA	E15	Regularly	Abundant (S)	Overpopulated (S)

SOURCE: Colorado Division of Wildlife, 1972.

Abbreviations Used - NA, (Data) Not available; E, Estimated

STREAM NAME - DRAINAGE SYSTEM: C, Creek; R, River; F, Fork; S, South; H, North; E, East

FISH SPECIES PRESENT: B, Brook Trout; C, Cutthroat Trout; R, Rainbow Trout; Br, Brown Trout; S, Suckers; W, Whitefish; Rough, Rough Fish; Cb, Chub; Ca, Carp; CC, Channel Catfish; Sq, Squawfish; Sc, Sculpin

*VALUE RATING SYSTEM: 60 and below, Poor; 61-74, Fair; 75-85, Good; 86 and above, Excellent

TABLE IX-2 (Cont.)

Characteristics Pertinent to the Evaluation of Stream Fisheries in the Study Region

Stream Name	Drainage System Name	Value Rating*	Fish Species Present (Percent of Total Population)	Mean Stream Flow (cfs)	Mean Stream Width (Feet)	Populations Being Maintained By Stocking (Species)	Populations Being Maintained By Natural Reproduction (Species)	Overall Population Conditions
Moffat County								
Little Bear C	Fortification C	100	B(30), C(40), R(30	1.5	2	Regularly	Some (c)	Underpopulated
Beaver C	Slater C	68	B(70), C(30)	1.5	3	Rarely	Abundant (B)	Overpopulated (B)
Deer C	Morapos C	88	B(30), C(70)	2.0	4	Occasionally	Some	Stable
Fortification C	Yampa River	95	B(40), C(40), R(20)	1.5	4	Occasionally	Some (B,C,R)	Overpopulated (B)
Green R	Colorado R	60	R(70), Br(5), Ca(10), Sq(T), S(10)	3,000	200	Regularly	Some	Stable
Little Snake R 1	**Yampa R**							
Little Snake	**Wyoming to Powder Wash**	85	B(2.5) Br(5), C(2.5), R(90)	150.0	70	Regularly	Some	Stable
Talamanies C	**Vermillion C**	88	Ca(80), Cc(120), Sq(T), S(T)	NA	E30	No	Abundant	Overpopulated
Yampa R	**Lily Park to Maybelle**	78	B(80), C(10), R(10)	1.0	2	Occasionally	Some	Stable
Yampa R	**Green R to Maybelle**	80	Cb(30), Cc(45), Br(5) R(5), Sq(15)	700.0	100	No	Some	Stable
Yampa R	**Lily Park to Maybelle**	63	W(10), Cc(5), (Br(5), R(10) Rough (70)	NA	E30	Regularly	Abundant (Rough)	Overpopulated (Rough)
Rio Blanco County								
Coal C	Little Beaver C	80	B(90), R(10)	8.0	6	No	Some	**Underpopulated**
Fish C	Yampa R	38	B(70), R(30)	0.5	5	Occasionally	Some	**Stable**
Morapos C	Williams F R	67	C(50), R(50)	3.0	6	Occasionally	Some	**Stable**
Pagoda C	S F Williams R	100	C(100)	3.0	6	No	Some	**Stable**
Trout C	Yampa R	43	B(80), C(10), R(10)	5.0	10	Regularly	Some	**Stable**
White R	Utah to Strawberry C	60	Br(10, Ca(10), Cc(30), Sc(10), Cb(10), S(10), R(10), W(10)	500.0	70	Rarely	Abundant (Cc, S,W)	Stable
N F White R	White R	92	B(20), C(20), Br(15), R(25), W(15), S(5)	300.0	40	Regularly	Some	Stable
E F Williams F R	Yampa R	100	C(90), R(5), W(5)	14.0	20	Occasionally	Some	Stable

SOURCE: Colorado Division of Wildlife, 1972.

Abbreviations Used: NA, (Data) Not Available; E, Estimated
STREAM NAME - DRAINAGE SYSTEM: C, Creek; R, River; F, Fork; S, South; N, North; E, East
FISH SPECIES PRESENT: B, Brook Trout; C, Cutthroat Trout; R, Rainbow Trout; Br, Brown Trout; S, Suckers; W, Whitefish Rough, Rough fish; Cb, Chub; Ca, Carp; CC, Channel Catfish; Sq, Squawfish; Sc, Sculpin
*VALUE RATING SYSTEM: 60 and below, Poor; 61-74, Fair; 75-85, Good; 86 and above, excellent

TABLE IX-2 (Cont.)

Characteristics Pertinent to the Evaluation of Lake Fisheries in the Study Region

Lake Name	Drainage System Name	Township and Range	Section	Average Surface Acres	Maximum Maximum Depth	Fish Species Present (Percent of Total Population	Populations Being Maintained By Stocking (Species)	Populations Being Maintained by Natural Reproduction (Species)	Overall Population Conditions
Routt County									
Gill Re	E F Williams F	3N88W	11	7	E8	C(100)	Rarely	Rarely	Under
Hahns Peak L	Willow C	10N86W	12	40	45	B(T), R(75), S(25)	Regularly	Common	Stable
Pearl L	Lester C	10N85W	35	167	83	B(10), C(60), R(10),S(20)	Occasionally	Common	Under
Sage Creek Re	Sage C	5N88W	13	20	E30	R(100)	No	Rarely	Under
Steamboat L	Willow C	10N86W	35	1,083	85	B(10), Br(5), C(T), R(85)	Regularly	Common	Stable
Moffat County									
Butch Cassidy Re	Green R	10N104W	12	100	17	B(90), C(8), R(2)	Rarely	Some	Stable
Freeman Re	Cottonwood C	9N89W	6	14	E30	C(100)	Occasionally	Rarely	Under
Hog L	Green R	10N103W	9	51	15	B(100)	Rarely	Rarely	Under
Ralph White L	Fortification C	8N90W	26	40	E15	Su(49), Bh(30), Cc(10), Np(1), R(10)	Regularly	Abundant	Over (Bg, Bh)
Rio Blanco County									
Axial Basin Re	Milk C	4N93W	13	20	E10	Bh(10), Su(3), R(80), Yp(3), Cc(2), Cr(2)	Regularly	Common	Stable
Chapman Re	Oak C	3N86W	31	25	26	B(T), C(T), R(99)	Regularly	Rarely	Stable
Pagoda L	Snell C	2N89W	23	7	16	B(90), R(10)	Occasionally	Rarely	Under
Rio Blanco L	White R	1N96W	6	120	15	Cb(10), Cp(50), S(20)Cc(10), Np(5), Bh(3), R(2)			
Sheriffs Re	Trout C	2N87W	20	40	E30	R(100)	Regularly	Rarely	Stable
Vaughn L	Poose C	2N88W	22	36	26	R(99), C(T)	Regularly	Rarely	Stable

SOURCE: Colorado Division of Wildlife, 1972

Abbreviations Used - LAKE NAME - DRAINAGE SYSTEM: C, Creek; L, Lake; Re, Reservoir; E, East; F, Fork
MAXIMUM DEPTH: E, Estimated
FISH SPECIES PRESENT: C, Cutthroat Trout; B, Brook Trout; R, Rainbow Trout; S, Sucker; Br, Brown Trout; Su, Sunfish; Bh, Bullhead Catfish; Cc, Channel Catfish; Np, Northern Pike; Yp, Yellow Perch; Cr, Crappie; Lmb, Largemouth Bass; K, Kokanee Salmon; Cb, Chub; Cp, Carp; (T), trace of species found in habitat.
OVERALL POPULATION CONDITION: Under, underpopulated; Over, overpopulated.

TABLE IX-3

Chemical Analyses for Upper Dry Creek in March, April and June 1974

Parameters	Mar 11		Apr 29	Jun 25	Aug	Oct	Dec	Mean
Dissolved Oxygen (mg/1)	10.6		8.3	7.0				
pH	8.54		8.52	7.7				
Temperature (^{o}C)	5.2		13.0	20.0				
Turbidity (JTU)	7		0	0				
PHTH Alkalinity ($CaCo_3$) (mg/1)	0		5	-				
Total Alkalinity ($CaCO_3$) (mg/1)	313		235	360				
Chloride (mg/1)	3.5		2.7	6.7				
Sulfate (mg/1)	199		118	200				
Calcium (mg/1)	95		59	99				
Magnesium (mg/1)	55		32	57				
Sodium (mg/1)	48		19	21				
Potassium (mg/1)	3.9		5.5	7.0				
Fluoride (mg/1)	-		0.72	0.84				
Silica (SiO_2) (mg/1)	12		8.5	15				
Specific Conductance (μmhos/cm)	961		610	958				
Total Dissolved Solids (mg/1)	692	*	372	708				
Ammonia (N) (mg/1)	0.28		< 0.1	0.35				
Nitrate (N) (mg/1)	0.29		0.30	0.13				
Kjeldahl (N) (mg/1)	<0.1		0.60	0.66				
Phosphorous, Ortho (mg/1)	<0.1		0.12	<0.1				
Phosphorous, Total (mg/1)	<0.1		0.22	<0.1				
Phosphorous, Soluble (mg/1)	-		0.12	<0.1				
BOD, 5 day (mg/1)	6.6		9.0	10				
BOD, 20 day (mg/1)			11.0	22				
Total Coliforms (MPN/100ml)	>2,400		>2,400	93				
Fecal Coliforms	23		4	<3				
COD	-		-	-				

---

* Analyses are for combined upper and lower Dry Creek.

TABLE IX-4

Chemical Analyses for Northern Tributary to Dry Creek in May and June 1974

Parameters	May 29	June 25	Aug 25	Oct	Dec	Mean
Dissolved Oxygen (mg/1)	-	6.0				
pH	-	7.9				
Temperature (^{o}C)	-	25				
Turbidity (JTU)	-	-				
PHTH Alkalinity ($CaCo_3$) (mg/1)	-	-				
Total Alkalinity ($CaCO_3$) (mg/1)	-	310				
Chloride (mg/1)	4.9	12				
Sulfate (mg/1)	914	594				
Calcium (mg/1)	220	127				
Magnesium (mg/1)	158	109				
Sodium (mg/1)	30	65				
Potassium (mg/1)	7.2	13				
Fluoride (mg/1)	1.3	0.70				
Silica (SiO_2) (mg/1)	16	8.5				
Specific Conductance (µmhos/cm)	1,973	1,489				
Total Dissolved Solids (mg/1)	1,856 *	1,252				
Ammonia (N) (mg/1)	<0.1	<0.1				
Nitrate (N) (mg/1)	0.45	0.11				
Kjeldahl (N) (mg/1)	0.25	0.86				
Phosphorous, Ortho (mg/1)	<0.1	<0.1				
Phosphorous, Total (mg/1)	<0.1	<0.1				
Phosphorous, Soluble (mg/1)	<0.1	<0.1				
BOD, 5 day (mg/1)	8	8				
BOD, 20 day (mg/1)	15	16				
Total Coliforms (MPN/100 ml)	1,100	120×10^2				
Fecal Colif (MPN/100 ml)	3	23				
COD	19	-				

---

* Analyses are for combined upper and lower Sage Creek samples.

TABLE IX-5

Chemical Analyses for Lower Dry Creek in March, April and June 1974

Parameters	Mar 11	Apr 29	Jun 25	Aug	Oct	Dec	Mean
Dissolved Oxygen (mg/1)	10.6	8.58	6.0				
pH	8.54	-	7.8				
Temperature (^{o}C)	2.0	10.0	23.5				
Turbidity (JTU)	20	620	5				
PHTH Alkalinity ($CaCO_3$) (mg/1)	0	0	-				
Total Alkalinity ($CaCO_3$) (mg/1)	370	235.0	295				
Chloride (mg/1)	3.5	3.0	8.5				
Sulfate (mg/1)	199	167.0	374				
Calcium (mg/1)	95	86.0	99				
Magnesium (mg/1)	55	44.0	77				
Sodium (mg/1)	48	18.0	44				
Potassium (mg/1)	3.9	6.6	7.0				
Fluoride (mg/1)	-	0.72	0.72		(discontinued)		
Silica (SiO_2) (mg/1)	12	10.3	9.0				
Specific Conductance (μmhos/cm)	961	678	1,136				
Total Dissolved Solids (mg/1)	692 *	470	862				
Ammonia (N) (mg/1)	0.28	<0.1	<0.1				
Nitrate (N) (mg/1)	0.29	0.85	<0.1				
Kjeldahl (N) (mg/1)	<0.1	2.6	0.84				
Phosphorous, Ortho (mg/1)	<0.1	<0.1	<0.1				
Phosphorous, Total (mg/1)	<0.1	<0.18	<0.1				
Phosphorous, Soluble (mg/1)	-	<0.1	<0.1				
BOD, 5 day (mg/1)	6.6	12	8				
BOD, 20 day (mg/1)		14	18				
Total Coliforms (MPN/100 ml)	>2,400	>2,400	39				
Fecal Coliforms (MPN/100 ml)	23	<15	9				
COD	-	-	-				

---

* Analyses are for combined upper and lower Dry Creek.

TABLE IX-6

Chemical Analyses for Upper Sage Creek in March, April and June 1974

Parameters	Mar 11		Apr 29	Jun 25	Aug	Oct	Dec	Mean
Dissolved Oxygen (mg/l)	9.0		9.7	7.0				
pH	-		8.6	7.3				
Temperature (°C)	6.0		5.0	16.0				
Turbidity (JTU)	0		5	10				
PHTH Alkalinity ($CaCO_3$) (mg/l)	0		0	-				
Total Alkalinity ($CaCO_3$) (mg/l)	229		141	215				
Chloride (mg/l)	1.5		0.2	1.0				
Sulfate (mg/l)	133		31.9	26				
Calcium (mg/l)	80		34	54				
Magnesium (mg/l)	40		15	24				
Sodium (mg/l)	19		3.1	4.3	(discontinued)			
Potassium (mg/l)	3.3		2.0	2.3				
Fluoride (mg/l)	-		0.5	0.56				
Silica (SiO_3) (mg/l)	7.5		9.0	12				
Specific Conductance (µmhos/cm)	702		291	459				
Total Dissolved Solids (mg/l)	494	*	152	294				
Ammonia (N) (mg/l)	.23		<0.1	0.32				
Nitrate (N) (mg/l)	.40		<0.1	<0.1				
Kjeldahl (N) (mg/l)	<0.1		0.48	0.56				
Phosphorous, Ortho (mg/l)	<0.1		<0.1	<0.1				
Phosphorous, Total (mg/l)	<0.1		0.18	<0.1				
Phosphorous, Soluble (mg/l)	-		<0.1	<0.1				
BOD, 5 day (mg/l)	2.4		9	6				
BOD, 20 day (mg/l)			12	11				
Total Coliforms (MPN/100 ml)	28		460	460				
Fecal Coliforms (MPN/100 ml)	<3		<2	<3				
COD	-		-	-				

---

* Analyses are for combined upper and lower Sage Creek samples.

TABLE IX-7

Chemical Analyses for Sage Creek below Sage Creek Reservoir in April and June 1974 [1]

Parameters	Mar 11	Apr 29	Jun 25	Aug	Oct	Dec	Mean
Dissolved Oxygen (mg/1)	(not sampled)	8.8	7.5				
pH		8.5	7.5				
Temperature (°C)		7.0	16.0				
Turbidity (JTU)		0	20				
PHTH Alkalinity ($CaCO_3$) (mg/1)		0	-				
Total Alkalinity ($CaCO_3$) (mg/1)		228.5	155				
Chloride (mg/1)		0.2	1.0				
Sulfate (mg/1)		258	64				
Calcium (mg/1)		103	48				
Magnesium (mg/1)		45	22				
Sodium (mg/1)		16	7.3	(discontinued)			
Potassium (mg/1)		5.3	4.2				
Fluoride (mg/1)		0.6	0.49				
Silica (SiO_3) (mg/1)		9.2	9.0				
Specific Conductance (μmhos/cm)		852	437				
Total Dissolved Solids (mg/1)		608	304				
Ammonia (N) (mg/1)		0.1	<0.1				
Nitrate (N) (mg/1)		0.43	0.27				
Kjeldahl (N) (mg/1)		0.62	0.74				
Phosphorous, Ortho (mg/1)		<0.1	<0.1				
Phosphorous, Total (mg/1)		0.14	<0.1				
Phosphorous, Soluble (mg/1)		<0.1	<0.1				
BOD, 5 day (mg/1)		5	3				
BOD, 20 day (mg/1)		7	8				
Total Coliforms (MPN/100 ml)		460	240				
Fecal Coliforms (MPN/100 ml)		<2	<3				
COD		-	-				

---

[1] Analyses area for combined upper and lower Sage Creek samples.

TABLE IX-8

Chemical Analyses of Lower Sage Creek in March, April and June 1974[1/]

Parameters	Mar 11	Apr 29	Jun 25	Aug	Oct	Dec	Mean
Dissolved Oxygen (mg/1)	10.5	8.1	8.7				
pH	8.68	8.65	8.1				
Temperature (°C)	4.2	11.5	16.5				
Turbidity (JTU)	6	180	0				
PHTH Alkalinity ($CaCO_3$)(mg/1)	0	0	-				
Total Alkalinity ($CaCO_3$) (mg/1)	272	205	160				
Chloride (mg/1)	1.5	0.3	1.0				
Sulfate (mg/1)	133	109	82				
Calcium (mg/1)	80	57	58				
Magnesium (mg/1)	40	30	28				
Sodium (mg/1)	19	12	6.8				
Potassium (mg/1)	3.3	5	4.2				
Fluoride (mg/1)	-	0.66	0.50				
Silica (SiO_2) (mg/1)	7.5	10	8.4				
Specific Conductance (μmhos/cm)	702	552	496				
Total Dissolved Solids (mg/1)	494 *	308	328				
Ammonia (N) (mg/1)	.23	<0.1	<0.1				
Nitrate (N) (mg/1)	.40	1.3	0.32				
Kjeldahl (N) (mg/1)	<0.1	1.7	0.60				
Phosphorous, Ortho (mg/1)	<0.1	<0.1	<0.1				
Phosphorous, Total (mg/1)	<0.1	0.22	<0.1				
Phosphorous, Soluble (mg/1)	-	0.1	<0.1				
BOD, 5 day (mg/1)	2.4	11	6				
BOD, 20 day (mg/1)	-	13	14				
Total Coliforms (MPN/100 ml)	28	75	75				
Fecal Coliforms (MPN/100 ml)	<3	<2	<3				
COD	-	-	-				

[1/] Analyses are for combined upper and lower Sage Creek samples.

Aquatic Biology

TABLE IX-9

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in Upper Dry Creek

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Tricladida		80		7.2%
Planariidae/*Phagocata* sp.	A		80	
Gastropoda		12		1.1%
Planorbidae/Unknown genus	A		4	
Physidae/*Physa* sp.	A		2	
Lymnaeidae/*Lymnaea* sp.	A		6	
Pelycepoda		483		43.4%
Sphaeriidae/*Pisidium* sp.	A		250	
Sphaeriidae/*Sphaerium* sp.	A		233	
Isopoda		7		0.6%
Gammaridae/*Gammarus lacustrus*	A		2	
Hyalellidae/*Hyalella azteca*	A		5	
Ephemeroptera		373		33.5%
Baetidae/*Baetis* sp.	A		373	
Plecoptera		2		0.2%
Nemouridae/*Nemoura* sp.	N		2	
Trichoptera		14		1.3%
Limnephilidae/*Hesperophylax* sp.	L		6	
Hydropshychidae/*Hydropsyche* sp.	L		8	
Coleoptera		6		0.5%
Elmidae/Unknown	L		6	
Diptera		136		12.2%
Chironomidae	L/P		40/6	
Simulidae/*Simulium* sp.	L/P		80/8	
Tipulidae/*Eriocera* sp.	L		2	
Total		1,113		100.0%

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-10

Number and Relative Abundance (by order) of Benthic Animals Caught with a Surber Sampler in Upper Dry Creek

Order Family/Taxon	Growth Stage 1/	Number2/		Relative Abundance
Oligochaeta		4		1.0%
Tubificidae	A		4	
Hydracarina	A	1		0.2%
Turbellaria		40		9.7%
Planaridae/poss. *Phagocota* sp.	A		40	
Gastropoda		3		0.7%
Physidae/*Physa* sp.	A		1	
Phanoribidae/poss. *Heliosoma campanulata*	Immat		2	
Pelycepoda		120		29.2%
Sphaeridae/*Sphaerium* sp.	A		120	
Amphipoda		31		7.5%
Hyalellidae/*Hyalella azteca*	A		28	
Gammaridae/*Gammarus lacustris*	A		3	
Ephemoroptera		67		16.3%
Bactidae/*Baetis* sp.	N		67	
Plecoptera		7		1.7%
Nemouridae/*Nemoura* sp.	N		7	
Trichoptera		1		0.2%
Limnephilidae/*Hesperophylax* sp.	P		1	
Coleoptera		7		1.7%
Elmidae	L		4	
Dytiscidae	L		1	
Unknown	L		1	
Unknown	A		1	

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-10 (Cont.)

Number and Relative Abundance (by order) of Benthic Animals Caught with a Surber Sampler in Upper Dry Creek

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Diptera		130		31.8%
Tipulidae/Tipula sp.	L	8/1		
poss. Dicranota sp.	L		3	
poss. Eriocera sp.	L		4	
Stratiomyiidae/Unknown "A"	L	7/2		
Unknown "B"	L		4	
Unknown "C"	L		1	
Simulidae	L	16/7		
	P		9	
Chironomidae	L	99/59		
	P		40	
Total		411		100.0%

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-11

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in Hubberson Gulch Near Confluence with Dry Creek

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Oligochaeta	A	2		1.9%
Tubificidae			2	
Hirudinea	A	1		0.9%
Gastropoda		3		2.9%
Physidae/*Physa* sp.	A		2	
Unknown	A		1	
Amphipoda		8		7.6%
Hyallelidae/*Hyallela azteca*	A		6	
Gammeridae/*Gammerus lacustris*	A		2	
Ephemeroptera		45		42.8%
Baetidae/*Baetis* sp.	N		45	
Plecoptera		9		8.6%
Perlodidae/*Isoperla patricia*	N		9	
Trichoptera		3		2.9%
Limnephilidae/*Hesperophylax* sp.	L		3	
Coleoptera				
Dytiscidae	A	2/1		1.9%
	L		1	
Diptera		32		30.5%
Simulidae	L		27	
Tipulidae/*Tipula* sp.	L		3	
Anthomyiidae/*Limnophora aquefrons*	L		1	
Chironomidae	L		1	
Total			105	100.0%

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-12

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in Lower Dry Creek

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Amphipoda		3		7.5%
Hyallelidae/*Hyalella azteca*	A		3	
Ephemeroptera		20		50.0%
Baetidae/*Baetis* sp.	N		20	
Trichoptera		6		15.0%
Hydropsychidae/*Hydropsyche* sp.	L		1	
Limnephilidae/*Hesperophylax* sp.	L		5	
Diptera		11		27.5%
Tipulidae/*Tipula* sp.	L		4	
Unknown genus	L		1	
Simulidae	L		4	
Chironomidae	L		2	
Total		40		100.0%

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-13

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in Upper Sage Creek

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Plesiopora		5		0.7%
Lumbriculidae	A		5	
Gastropoda		4		0.5%
Lymnaeidae/*Lymnaea* sp.	A		4	
Ephemeroptera		175		24.1%
Baetidae/*Callibaetis* sp.	N		3	
Baetidae/*Baetis* sp.	N		172	
Plecoptera		47		6.5%
Chloroperlidae/*Alloperla* sp.	N		18	
Perlodidae/*Isoperla patricia*	N		20	
Nemouridae/*Nemoura* sp.	N		9	
Trichoptera		42		5.8%
Limnephilidae/*Limnephilus* sp.	L		38	
Hesperophylax sp.	L		4	
Coleoptera		11		1.5%
Dytiscidae/*Agabinus* sp.	L		5	
Dytiscidae/*Agabinus* sp.	A		6	
Diptera		442		60.9%
Simulidae	L		417	
Chironomidae	L		22	
Tipulidae/*Dicranota* sp.	L		3	
Total		726		100.0%

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-14

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in Sage Creek below Sage Creek Reservoir

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Oligochaeta		82		40.3%
Lumbriculidae	A		82	
Gastropoda	A	1		0.5%
Amphipoda		6		3.0%
Hyalellidae/*Hyalella azteca*	A		6	
Ephemeroptera		34		16.8%
Baetidae/*Baetis* sp.	N		34	
Plecoptera		2		1.0%
Perlodidae/*Isoperla patricia*	N		2	
Trichoptera		2		1.0%
Limnephilidae/*Hesperophylax* sp.	L		2	
Coleoptera		2		1.0%
Elmidae/*Promoresia* sp.	L		2	
Diptera		74		36.4%
Tipulidae	L		1	
Simulidae	L		42	
Chironomidae	L		30	
Empediadae/poss. *Hemerodromia* sp.	L		1	
Total				

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-15

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in Lower Sage Creek

Order Family/Taxon	Growth Stage[1]	Number[2]		Relative Abundance
Oligochaeta		1		0.8%
Lumbriculidae	A		1	
Gastropoda	A	3		2.5%
Pelycepoda		6		4.9%
Sphaeridae/*Sphaerium* sp.	A		6	
Ephemeroptera		49		40.1%
Baetidae/*Baetis* sp.	N		49	
Plecoptera		21		17.2%
Perlodidae/*Isoperla patricia*	N		21	
Hemiptera		1		0.8%
Veliidae/*Microvelia* sp.	N		1	
Trichoptera		17		14.0%
Hydropsychidae/*Hydropsyche* sp.	L		3	
Limnephilidae/*Hesperophylas* sp.	L		10	
Unknown sp.	L		4	
Coleptera		16		13.1%
Elmidae/*Optioservus* sp.	L		11	
Heterlimnius sp.	A		5	
Diptera		8		6.6%
Tipulidae/*Eriocera* sp.	L		4	
Unknown genus	L		1	
Chironomidae	A		3	
Total		122		100.0%

---

[1] Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

[2] Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-16

Number and Relative Abundance (by order) of Benthic Animals Caught with a Surber Sampler in Grassy Creek

Order Family/Taxon	Growth Stage [1]	Number [2]		Relative Abundance
(a. Middle of stream)				
Ephemeroptera		1		4.0%
Baetidae/Baetis sp.	N		1	
Diptera		24		96.0%
Chironomidae	L		22	
	P		2	
Fish eggs			6/3	
Fish larvae			3	
Total			25	100.0%
(b. Near stream bank)				
Oligochaeta		1		1.1%
Unknown			1	
Trichoptera		1		1.1%
Hydrophsychidae/Cheumatopsyche sp.			1	
Diptera		91		97.8%
Simulidae	L		2	
Chironomidae	L		83	
	P		6	
Total			93	100.0%

[1] Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

[2] Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-17

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in the "Mudslide" Lake in Section 15

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Oligochaeta		20		54.1%
Tubificidae	A		20	
Ephemeroptera		2		5.4%
Baetidae/*Callibaetis* sp.	A		1	
Baetis sp.	A		1	
Zygoptera		1		2.7%
Coenagrionidae/*Enallagma* sp.	N		1	
Hempitera		4		10.8%
Corixididae/*Hesperocorixa* sp.	N		4	
Coleoptera		4		10.8%
Dytiscidae/*Hydroporus* sp.	L		3	
Unknown sp.	A		1	
Diptera		6		16.2%
Chironomidae	L		6	
Salamander embryo			1	
Total		37		100.0%

1/ Growth stages include a - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-18

Number and Relative Abundance (by order) of Benthic Animals Caught with a Dip-net in the Uppermost Beaver Pond in Section 27

Order Family/Taxon	Growth Stage 1/	Number 2/		Relative Abundance
Oligochaeta		30		8.2%
Tubificidae	A		30	
Hirudinea		1		0.3%
Erpobdellidae	A		1	
Gastropoda		8		2.2%
Physidae/*Physa* sp.	A		8	
Acari	A	2/2		0.5%
Amphipoda		232		63.5%
Hyalellidae/*Hyalella azteca*	A		215	
Gammaridae/*Gammarus lacustris*	A		17	
Ephemeroptera		79		21.6%
Baetidae/*Callibaetis* sp.	N		52	
Beatis sp.	N		27	
Odonata		2		0.5%
Coenagrionidae/*Ischnura* sp.	N		2	
Hemiptera		3		0.8%
Corixidae/*Graptocorixa* sp.	A		1	
Unknown sp.	A		1	
Notonectidae/*Notonecta* sp.	A		1	
Trichoptera		3		0.8%
Limnephilidae/Unknown pupae	L/P		3	
Coleoptera		2		0.5%
Dyatiscidae	L		1	
Haliplidae	A		1	
Diptera		4		1.1%
Simulidae	A		1	
Chironomidae	A		3	
Total		366		100.0%

1/ Growth stages include A - adult, N - nymph, L - larvae, and P - pupal.

2/ Numbers on left indicate total per order; numbers on right indicate total per species.

TABLE IX-19

Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July, August, and September, 1975 at Each Station on Fish Creek 1/

Taxon	STATION								
	Upper			Middle			Lower		
	July	Aug	Sept	July	Aug	Sept	July	Aug	Sept
Class Insects: Insects									
Order Diptera: True Flies									
Family Heleidae: Biting Midges	1	-	3	-	-	-	-	2	12
Tendipedidae: Midges	7	7	20	-	398	361	-	1114	566
Simulidae: Black Flies	3	-	5	-	-	6	5	-	186
Tipulidae: Crane Flies	-	3	3	-	4	-	-	-	8
Rhagionidae: Snipe Flies	-	6	16	-	-	-	-	1	4
Order Ephemeroptera: Mayflies									
Family Beatidae: Baetids	69	84	44	-	11	20	6	12	80
Heptageniidae: Clinging Mayflies	6	-	7	-	-	-	4	1	-
Tricorythidae: Sprawling Mayflies	-	79	7	-	160	7	1	134	14
Leptophlebiidae: Leptophlebiids	-	-	19	-	99	2	-	18	-
Ephemerellidae: Clinging Mayflies	-	-	7	-	-	-	-	-	-
Order Trichoptera: Caddis Flies									
Family Hydropsychidae: Seine-making Caddis Flies	38	21	288	10	152	75	1	290	2984
Brachycentridae: Log Cabin Case-Making Caddis Flies	1	2	-	-	-	-	-	-	-

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

TABLE IX-19 (Cont.) 1/

Taxon	STATION Upper July	 Upper Aug	 Upper Sept	 Middle July	 Middle Aug	 Middle Sept	 Lower July	 Lower Aug	 Lower Sept
Family Hydroptilidae: Purse-making Caddis Flies	-	19	32	-	45	-	-	428	-
Leptoceridae: Leptocerids	-	-	-	-	-	-	-	-	16
Glossosomatidae: Turtle-shell Case Builders	-	-	-	-	11	-	-	4	-
Helicopsychidae: Snail-shell Case Builders	-	-	-	-	-	-	-	3	6
Limnephilidae: Limnephilids	-	-	6	-	-	-	-	-	-
Psychomyiidae: Silken-tube Caddis Flies	-	-	-	-	-	-	-	10	-
Order Plecoptera: Stone Flies									
Family Perlodidae: Perlodids	-	16	20	-	-	-	-	-	-
Nemouridae: Nemourids	-	6	-	-	-	-	-	-	-
Chloroperlidae: Chloroperlids	-	-	10	-	-	-	-	-	-
Pteronareidae: Pteronareids	-	-	14	-	-	-	-	-	-
Order Coleoptera: Water Beetles									
Family Elmidae: Elmids	15	63	233	-	12	9	1	14	58
Dytiscidae: Predaceous Diving Beetles	-	-	-	-	1	-	-	-	-

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

TABLE IX-19 (Cont.) 1/

Taxon	STATION								
	Upper			Middle			Lower		
	July	Aug	Sept	July	Aug	Sept	July	Aug	Sept
Family Dryopidae: Dryopids	-	-	1	-	-	-	-	-	2
Order Hemiptera: True Bugs									
Family Corixidae: Water Boatmen	-	1	-	-	-	-	-	24	10
Naucoridae: Creeping Water Bugs	-	-	-	-	6	-	-	-	-
Order Odonata: Dragonflies and Damselflies									
Family Gomphidae: Gomphids	-	-	-	-	-	1	-	1	-
Other Invertebrates									
Phylum Annelida: Aquatic Earthworms									
Class Oligochaeta: Aquatic Earthworms									
Order Plesiopora: Aquatic Earthworms	-	-	24	-	87	104	1	325	88
Phylum Arthropoda: Arthropods									
Class Crustacea: Crustaceans									
Family Talitridae: Water Fleas	-	-	-	-	1	1	-	1	-

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

Aquatic Biology

TABLE IX-19 (Cont.) 1/

Taxon	STATION								
	Upper			Middle			Lower		
	July	Aug	Sept	July	Aug	Sept	July	Aug	Sept
Class Arachnoidea: Spiders and Mites									
Order Hydracarina: Water Mites	-	-	-	-	15	-	-	17	4
Phylum Mollusca: Snails and Clams									
Class Gastropoda: Snails									
Family Physidae: Physids	-	-	-	-	-	3	-	2	20
Ancylidae: Limpets	-	-	-	-	5	-	-	-	-
Sphaeriidae: Sphaerids	-	-	-	-	-	-	-	1	-
Phylum Nematoda: Roundworms	-	-	1	-	-	-	-	-	-

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

Aquatic Biology

TABLE IX-20

Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July, August, and September, 1975 at Each Station on Trout Creek [1/]

Taxon	STATION					
	Upper			Lower		
	July	Aug	Sept	July	Aug	Sept
Class Insecta: Insects						
Order Diptera: True Flies						
Family Tendipedidae: Midges	2	94	55	6	2544	128
Tipulidae: Crane Flies	1	-	-	-	-	17
Simulidae: Black Flies	-	72	3	2	102	2
Heleidae: Biting Midges	-	-	-	2	2	-
Rhagionidae: Snipe Flies	-	1	-	-	-	-
Musidae: Musids	-	-	1	-	-	-
Stratiomyidae: Soldier Flies	-	-	4	-	-	-
Order Ephemeroptera: Mayflies						
Family Baetidae: Baetids	11	54	76	17	186	82
Ephemerellidae: Clinging Mayflies	1	15	2	4	86	10
Tricorythidae: Sprawling Mayflies	-	-	2	19	1710	49
Heptagenidae: Clinging Mayflies	-	1	29	-	-	10

[1/] **SOURCE: Baseline Environmental Report (Dames and Moore, 1975).**

TABLE IX-20 (Cont.) 1/

Taxon	Upper July	Upper Aug	Upper Sept	Lower July	Lower Aug	Lower Sept
Order Trichoptera: Caddis Flies						
Family Helicopsychidae: Snail-shell Case Builders	5	1	14	-	-	14
Glossosomatidae: Turtle-shell Case Builders	1	55	22	-	6	6
Leptoceridae: Leptocerids	1	-	-	-	-	3
Philopotamidae: Philopotamids	-	10	-	-	-	-
Brachycentridae: Log Cabin Case Builders	-	32	15	-	-	-
Hydropsychidae: Seine-making Caddis Flies	-	68	428	-	68	329
Hydroptilidae: Purse-making Caddis Flies	-	21	4	-	90	4
Hydropsychidae: Seine-making Caddis Flies	-	68	428	-	68	329
Limnephilidae: Limnephilids	-	-	1	-	-	-
Order Plecoptera: Stone Flies						
Family Perlodidae: Perlodids	-	10	16	-	2	18
Nemouridae: Nemourids	-	10	-	-	-	-
Perlidae: Perlids	-	1	1	-	-	-

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

Aquatic Biology

TABLE IX-20 (Cont.) 1/

Taxon	STATION					
	Upper			Lower		
	July	Aug	Sept	July	Aug	Sept
Chloroperlidae: Chloroperlids	-	-	-	-	-	1
Order Coleoptera: Water Beetles						
Family Elmidae: Elmids	-	99	100	-	80	25
Other Invertebrates						
Phylum Annelida: Aquatic Earthworms						
Class Oligochaete: Aquatic Earthworms						
Order Plesiopora: Aquatic Earthworms	2	-	-	26	1182	7
Phylum Nematoda: Roundworms	2	2	2	-	-	-
Phylum Mollusca: Snails and Clams						
Class Pelecypoda: Clams						
Family Sphaeriidae: Sphaerids	1	-	-	-	-	1
Class Gastropoda: Snails						
Family Physidae: Physids	2	-	-	-	4	2
Ancylidae: Limpets	-	-	-	-	2	5
Phylum Arthropoda: Arthropods						
Class Arachnoidea: Spiders and Mites						
Order Hydracarina: Water Mites	-	-	-	-	18	2

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

TABLE IX-21

Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July and August, 1975 at Each Station on Foidel Creek [1]

Taxon	STATION			
	Upper		Lower	
	July	Aug	July	Aug
Class Insecta: Insects				
Order Diptera: True Flies				
Family Tendipedidae: Midges	70	587	76	1703
Simulidae: Black Flies	2	-	151	890
Musidae: Musids	-	-	1	3
Heleidae: Biting Midges	-	46	-	50
Order Ephemeroptera: Mayflies				
Family Baetidae: Baetids	-	-	-	2
Order Trichoptera: Caddis Flies				
Family Hydropsychidae: Seine-making Caddis Flies	-	-	-	5
Hydroptilidae: Purse-making Caddis Flies	-	1	-	50
Limnephilidae: Limnephilids	-	4	-	-
Order Coleoptera: Water Beetles				
Family Elmidae: Elmids	4	1	-	7
Haliplidae: Crawling Water Beetles	1	1	-	-

[1] SOURCE: Baseline Environmental Report (Dames and Moore 1975).

TABLE IX-21 (Cont.) 1/

Taxon	STATION Upper July	STATION Upper Aug	STATION Lower July	STATION Lower Aug
Family Dytiscidae: Predaceous Diving Beetles	-	1	1	-
Hydrophilidae: Water Scavenger Beetles	-	9	-	1
Order Hemiptera: True Bugs				
Family Corixidae: Water Boatmen	1	-	-	-
Veliidae: Broad-shouldered Water Striders	-	1	-	-
Other Invertebrates				
Phylum Nematoda: Round Worms	-	2	29	48
Phylum Annelida: Aquatic Earthworms				
Class Oligochaeta: Aquatic Earthworms				
Order Plesiopora: Aquatic Earthworms	3	18	225	359
Class Hirudinea: Leeches				
Family Glossiphoniidae	1	3	-	-
Phylum Arthropoda: Arthropods				

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

Aquatic Biology

TABLE IX-21 (Cont.) 1/

Taxon	STATION			
	Upper		Lower	
	July	Aug	July	Aug
Class Crustacea: Crustaceans				
Family Talitridae: Water Fleas	8	133	-	23
Gammaridae: Water Fleas	-	199	-	1
Astacidae: Crayfish	-	-	3	-
Subclass Ostracoda: Seed Shrimps				
Order Podocopa: Seed Shrimps	-	6	-	-
Class Arachnoidea: Spiders and Mites				
Order Hydracarina: Water Mites	-	1	-	-
Phylum Mollusca: Snails and Clams				
Class Gastropoda: Snails				
Family Physidae: Physids	-	-	-	13
Lymnaeidae: Lymnaeids	-	-	-	13

---

[1] SOURCE: Baseline Environmental Report (Dames and Moore 1975).

TABLE IX-22

Numbers and Kinds of Benthic Macroinvertebrates Collected in One Surber Bottom Sample in July, August, and September, 1975 at Each Station on Middle Creek 1/

Taxon	STATION					
	Upper			Lower		
	July	Aug	Sept	July	Aug	Sept
Class Insecta: Insects						
Order Diptera: True Flies						
Family Tendipedidae: Midges	36	126	96	19	33	198
Simulidae: Black Flies	14	-	-	6	-	30
Tipulidae: Crane Flies	-	-	12	1	-	20
Stratiomyidae: Soldier Flies	1	-	-	-	-	-
Heleidae: Biting Midges	-	18	18	1	-	6
Empididae: Empidids	-	1	-	-	-	-
Musidae: Musids	-	1	-	-	-	8
Tabanidae: Horse Flies	-	-	1	-	-	-
Order Ephemeroptera: Mayflies						
Family Baetidae: Baetids	116	-	-	22	18	94
Heptageniidae: Clinging Mayflies	19	-	-	1	-	-
Ephemerellidae: Clinging Mayflies	1	-	-	-	-	-
Leptophlebiidae: Leptophlebiids	-	2	-	-	-	-
Tricorythyidae: Sprawling Mayflies	-	-	-	-	45	36

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

TABLE IX-22 (Cont.)

Taxon	STATION					
	Upper			Lower		
	July	Aug	Sept	July	Aug	Sept
Order Trichoptera: Caddis Flies						
Family Limnephilidae: Limnephilids	1	-	-	3	-	-
Hydroptilidae: Purse-making Caddis Flies	8	-	-	1	-	-
Hydropsychidae: Seine-making Caddis Flies	3	-	1	-	2	30
Brachycentridae: Log Cabin Case-Making Caddis Flies	1	-	-	-	-	-
Psychomyiidae: Silken-tube Caddis Flies	1	-	-	-	-	-
Limnephilidae: Limnephilids	-	-	-	-	1	2
Order Plecoptera: Stone Flies						
Family Nemouridae: Nemourids	6	-	-	-	-	-
Order Coleoptera: Water Beetles						
Family Elmidae: Elmids	13	-	1	9	27	84
Dytiscidae: Predaceous Diving Beetles	1	2	-	-	2	-
Hydrophilidae: Water Scavenger Beetles	-	-	-	-	-	8

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

TABLE IX-22 (Cont.)

Taxon	STATION					
	Upper			Lower		
	July	Aug	Sept	July	Aug	Sept
Order Hemiptera: True Bugs						
Family Veliidae: Broad-shouldered Water Striders	-	-	-	-	-	2
Corixidae: Water Boatmen	-	-	-	-	-	2
Other Invertebrates						
Phylum Nematoda: Roundworms	1	3	-	2	-	-
Phylum Annelida: Aquatic Earthworms						
Class Oligochaeta: Aquatic Earthworms						
Order Plesiopora: Aquatic Earthworms	6	677	163	62	5	70
Class Hirudinea: Leeches						
Family Glossiphonidae: Glossiphonids	-	-	-	2	-	4
Phylum Arthropoda: Arthropods						
Class Crustacea: Crustaceans						
Family Talitridae: Water Fleas	1	1	-	-	5	14
Gammaridae: Water Fleas	-	-	-	-	-	10
Subclass Ostracoda: Seed Shrimps						

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

Aquatic Biology

TABLE IX-22 (Cont.)

Taxon	STATION					
	Upper			Lower		
	July	Aug	Sept	July	Aug	Sept
Order Podocopa: Seed Shrimps	-	-	2	-	-	-
Class Arachnoidea: Spiders and Mites						
Order Hydracarina: Water Mites	-	-	-	-	-	4
Phylum Mollusca: Snails and Clams						
Class Pelecypoda: Clams						
Family Sphaeriidae: Sphaerids	-	-	-	1	-	6
Class Gastropoda: Snails						
Family Physidae: Physids	1	1	-	-	13	40
Lymnaeidae: Lymnaeids	-	-	-	-	-	4

1/ SOURCE: Baseline Environmental Report (Dames and Moore 1975).

Recreation

APPENDIX D

TABLE OF CONTENTS
FOR
RECREATION

Table	Title	Page
X-1	Coliform Stream Sampling Results--------------------------	X-1-2
X-2	U.S. Forest Service Recreation Developments---------------	X-3
X-3	Dinosaur National Monument Recreation Sites in Colorado---	X-4
X-4	Colorado Division of Wildlife Recreation Developments-----	X-5
X-5	Municipal, County, and Quasi-Public Recreation Facilities-	X-6-8
X-6	Private Recreation Facilities (SCS, 1974)-----------------	X-9-18
X-7	Sportsman's Club Leases-----------------------------------	X-19
X-8	Routt National Forest Recreation Use by Kinds of Sites----	X-20
X-9	White River National Forest Recreation Use by Kinds of Sites (Blanco Ranger District Only)---------------------	X-21
X-10	Dinosaur National Monument Public Use Statistics----------	X-22
X-11	1973 Small Game - Waterfowl Hunting Pressure--------------	X-23
X-12	Big Game Hunting Pressure 1973----------------------------	X-24
X-13	Big Game Hunter Residence 1973, Resident Deer Hunters-----	X-25
X-14	Big Game Hunter Residence 1973, Non-Resident Deer Hunters---	X-26-27
X-15	Big Game Hunter Residence 1973, Resident Elk Hunters------	X-28
X-16	Big Game Hunter Residence 1973, Non-Resident Elk Hunters--	X-29-30
X-17	Fishing Visitor-Use Information for Lakes and Reservoirs in the Study Region-------------------------------------	X-31-32
X-18	Fishing Visitor-Use Information---------------------------	X-33-35
X-19	1974 Fishery Questionnaire - User Origin------------------	X-36

TABLE X-1

Coliform Stream Sampling Results

Stream	Type of Measure	Parameters*	
		Total Coliform	Fecal Coliform
White River at Rangely (Class B_2)	Mean	4474.53[1]	689.2[1] 346.3[2]
	Maximum	33000.0[1]	4900.0[1] 2200.0[2]
	Minimum	96.0[1]	5.0[1] 2.2[2]
White River, below Piceance Creek (Class B_2)	Mean	2768.0[1]	2503.3[2]
	Maximum	22000.0[1]	22000.0[2]
	Minimum	30.0[1]	5.0[2]
White River at Meeker (Class B_1)	Mean	-	-
	Maximum	-	-
	Minimum	-	-
Yampa River, below Little Snake River (Class B_2)	Mean	745.0[1]	117.7[1] 22.7[2]
	Maximum	7900.0[1]	790.0[1] 38.0[2]
	Minimum	5.0[1]	2.0[1] 8.0[2]
Yampa River, near Maybell (Class B_2)	Mean	756.1[1]	112.1[1] 240.0[2]
	Maximum	4900.0[1]	1300.0[1] 240.0[2]
	Minimum	2.2[1]	2.0[1] 240.0[2]

* per 100 ml.

SOURCE: STORET, Environmental Protection Agency, 1974.

TABLE X-1 (Cont.)

Coliform Stream Sampling Results

		Parameters*	
Stream	Type of Measure	Total Coliform	Fecal Coliform
Yampa River at Milner (Class B_1)	Mean	2498.2[1]	865.3[1] 244.4[2]
	Maximum	23000.0[1]	22000.0[1] 500.0[2]
	Minimum	15.0[1]	2.0[1] 2.2[2]
Yampa River, above Oak Creek confluence (Class B_1)	Mean	1949.0[1]	75.5[2]
	Maximum	30000.0[1]	300.0[2]
	Minimum	2.2[1]	2.2[2]
Little Snake River, above Lily Park (Class B_1)	Mean	2680.6[1]	255.2[1] 129.0[2]
	Maximum	30000.0[1]	3000.0[1] 200.0[2]
	Minimum	15.0[1]	2.0[1] 38.0[2]

1. **Compiled from lab tests that confirm the Most Probable Number (MPN) through a determination of the presence of Colifrom bacteria. This is the state standard method for Colorado. (SOURCE: 1974 - Green River Basin Water Quality Mgmt. Plan).**

2. **Compiled from lab tests using the Media Filter Method (MFM) wherein an actual count of coliform groups is made. This is the most accurate and reliable method.**

* per 100 ml.

SOURCE: STORET, Environmental Protection Agency, 1974.

TABLE X-2

U.S. Forest Service Recreation Developments

Name	Camp Units	Picnic Units	Drinking Water	Boat Ramp	Small Trailer
Freeman Campground (C.G.)	12	--	--	--	X
Sawmill C.G.	5	1	X	--	X
Hahns Peak Lake C.G.	26	--	X	X	X
Hinman C.G.	13	--	X	--	X
Box Canyon C.G.	11	--	--	--	X
Seedhouse C.G.	24	6	X	--	X
Summit Lake C.G.	9	8	X	--	X
Granite C.G.	6	--	--	X	--
Dry Lake C.G.	8	--	X	--	X
Ferndale Picnic ground(P.G.)	--	9	X	--	--
Harrison Creek P.G.	--	4	X	--	--
Meadows C.G.	32	--	X	--	X
Walton Creek C.G.	14	--	X	--	X
Dumont Lake C.G.	12	11	X	--	X
Lynx Pass C.G.	12	--	X	--	X
Toponas Creek C.G.	5	--	X	--	X
Stillwater C.G.	9	4	X	--	X
Horseshoe C.G.	6	--	X	--	X
Cold Springs C.G.	5	--	X	--	X
Vaughn Lake C.G.	8	--	--	--	X
North Fork C.G.	47	--	X	--	X
Marvine C.G.	16	--	(Stream)	--	X
Himes Peak C.G.	8	--	(Stream)	--	X
Trappers Lake C.G.	51	--	X	--	X
Hill Creek C.G.	10	--	(Stream)	--	X
South Fork C.G.	17	--	(River)	--	X
East Marvine C.G.	7	--	(Stream)	--	X

SOURCE: U.S. Forest Service, RIM Directory -- Information for National Forests.

TABLE X-3

Dinosaur National Monument Recreation Sites in Colorado

Name	Activity-Facility
Gates of Lodore Campground (C. G.)	17 units; tables, trailer sites and water. One boat ramp. Ranger station.
Deerlodge Park C.G.	8 units; tables and toilets. Water in summer. One boat ramp.
Echo Park C.G.	20 units; tables and water. One boat ramp. Seasonal ranger station.
Primitive River Camps	4 on Green River (in Colo.) and 5 on Yampa River.
Plug Hat Picnic ground (P.G.)	10 tables, limited water.
Echo Park P.G.	5 tables.
Canyon P.G.	8 tables.
Dinosaur Headquarters & Visitor Center	Auditorium and display room.

SOURCE: Dinosaur National Monument, facilities (unpublished) 1975.

TABLE X-4

Colorado Division of Wildlife Recreation Developments

Name	Acres	Activity-Facility
Service Creek C.G.	311	River fishing, horseback riding, hiking (foot trail), camping, and picnicking.
Indian Run C.G.	2,044	River fishing and tubing, camping, picnicking, horseback riding, hiking, and four-wheel driving.
Bel Air Rearing Station	178	Viewing trout rearing ponds and tent camping (4 sites).
Cristina Picnic ground	-	Picnicking and river fishing.
Cold Springs Primitive Hunter Camps (DOW - BLM cooperative)	-	Open space camping and picnicking on national resource lands (NRL), hunting, and horseback riding. Includes camps at No Name Spring, Bishop Spring, Rocky Reservoir, Pines, Calloway, and Wiggins.
Ralph White Reservoir	299	Open space camping and picnicking, boating (one ramp), water-skiing, and fishing.
Rio Blanco Lake	383	Boating (one ramp), water-skiing, fishing, and waterfowl hunting. Facilities include one trailer camping site and 16 picnic sites.
Lake Avery	2,172	Boating (one ramp), water-skiing, fishing, and bird-watching. Facilities include 25 picnicking sites plus open-space camping and picnicking. No water; sewer dump station.
White River Public Fishing Easements (4)	est. 3 1/2 mi.	Two lie immediately below Meeker and two lie east of Meeker between town and Lake Avery.
Elk River Fishing Easement	2 1/2 mi.	From Mad Creek Canyon downstream to Elk River bridge.

SOURCES: Colorado Division of Parks, 1974 Interim Comprehensive Outdoor Recreation Plan.
Bureau of Land Management, Craig District Office, 1975.

TABLE X-5

Municipal, County and Quasi-Public Recreation Facilities

Location	Acreage	Activity-Facility
Steamboat Springs City Park	8	Playgrounds, open space, picnicking (8 sites), and fishing.
Steamboat Springs Municipal Pool	0.25	Swimming (indoor and outdoor) and 2 tennis courts.
Riverbend Golf Course	40	Nine holes, 40 acres.
Steamboat Schools (2 sites)	2 & 5	Playgrounds. Playgrounds and 2 tennis courts.
Hayden Schools	5	Playgrounds.
Steamboat Springs County Park	5	Playgrounds, open space, and horseback riding.
Howelson Hill, Steamboat Springs Winter Sports Club	-	Ski jumping, 3 jumps (15, 30 and 60 meter). Baseball diamond, soccer and rugby field, rodeo arena, and ice rink.
Yampa Valley Golf Association (Craig)	120	Nine hole golf course.
Craig City Park	4	Playgrounds, tennis (3 cts.), camping, picnicking (12 sites), basketball (1 ct.), swimming pool, and ice skating rink.
Maybell City Park	2	Playground, trailer camping (18 sites), and picnicking (18 sites).

TABLE X-5 (Cont.)

Location	Acreage	Activity-Facility
Craig schools	4	Playgrounds.
(4 sites)	4	Playgrounds.
	4	Playgrounds.
	25	Playgrounds.
Hamilton schools	1	Playgrounds.
Maybell schools	3	Playgrounds.
Lay schools	10	Playgrounds.
Powder Wash schools	0.25	Playgrounds.
Browns Park Schools	0.5	Playgrounds.
Dinosaur schools	3	Playgrounds.
Rangely City Park	5	Playgrounds and swimming pool.
Slush Pit Golf Course	30	Nine hole golf course at Chevron oil camp.
Rangely Schools	2	Playgrounds.
(3 sites)	5.2	Playgrounds.
	10	Playgrounds.
Rangely College	10	Playground for field games.
Meeker City Park	5	Playground, camping, fishing, river tubing, ice skating, and swimming pool.
Meeker Golf Course	20	Nine hole golf course.

TABLE X-5 (Cont.)

Location	Acreage	Activity-Facility
White River Recreation Area	-	Picnicking and camping, tables, sewer dump station.
Meeker schools (3 sites)	1.5	Playgrounds.
	3	Playgrounds and 2 tennis courts.
	14	Playgrounds.

SOURCES: Colorado Division of Parks, 1974 Interim Comprehensive Outdoor Recreation Plan. Bureau of Land Management, Craig District office, White River URA-MFP, 1975.

Recreation

TABLE X-6

Private Recreation Facilities (SCS, 1974)

Name	No.	Activity-Facility
In Moffat County:		
KOA Campground east of Craig	1	Transient camping, 6 acres, 57 vehicle sites, and 12 tent sites.
Carl Walgreen	2	Transient camping, 150 acres, 35 vehicle sites, and 25 tent sites.
Craig Gun Club	3	Shooting range, 5 positions.
Milliken Land and Cattle Co.	4	Fishing, 1 lake, 13 acres.
Ton Grieves	5	Fishing, 2 lakes, 10 acres.
Don Seick	6	Fishing, 1 lake, one acre.
Craig Stock Car Assoc.	7	Racetrack, 5 acres, 600 spectators.
Mrs. Stell Craig Juniper Hot Springs	8	Recreation resort, 20 acres, 40 guests. Swimming pool, 1875 sq.ft. Day camping, 2 acres, 15 guests.
Maybell Roping Arena	9	One acre.
Deer Creek Roping Arena	10	Two acres.
Cathy Cisar Association	11	Beginners -- youth ski area, rope tow, four acres, 275 skiers/hr. lift capacity.
Three Springs Ranch	12	Big game hunting, 12,000 acres.

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Tom Blevins	13	Big game hunting, 160 acres.
Albert Camilletti	14	Big game hunting, 1440 acres.
Ed Clark	15	Big game hunting, 1240 acres.
Durham Livestock	16	Big game hunting, 5922 acres.
Lorence Ellgen	17	Big game hunting, 1936 acres.
Leon Fedinec	18	Big game hunting, 2940 acres.
Greg Hilton	19	Big game hunting, 6370 acres.
Boy Lyons	20	Big game hunting, 1200 acres.
Tim Mantle	21	Big game hunting, 1800 acres.
Sam McIntyre	22	Big game hunting, 1080 acres.
Ken Osborn	23	Big game hunting, 714 acres.
Bruce Seely	24	Big game hunting, 18,760 acres.
David Seely	25	Big game hunting, 18,056 acres.
Dan Sherman	26	Big game hunting, 6,582 acres.
Bob Simpson	27	Big game hunting, 200 acres.
Darryl Steele	28	Big game hunting, 280 acres.
Boyd Walker	29	Big game hunting, 5,320 acres.

Recreation

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Gilbert Williams	30	Big game hunting, 1,607 acres.
Paul Zingheim	31	Big game hunting, 1,080 acres.
Mary Sullivan	32	Big game hunting, 400 acres.
Wes Raley	33	Big game hunting, 3,360 acres.
Martin Bros.	34	Big game hunting, 5,000 acres.
In Routt County:		
Frances Marsh	35	Big game hunting, 2,700 acres.
Focus Ranch	36	Dude ranch, 30 guest. Horseback riding, 25 miles trails, 30 horse rentals. Hunting, 577 acres.
Donald Ely	37	Big game hunting, 1,219 acres.
Hahns Peak	38	Historical site, 40 acres.
Boot Jack Ranch, Glen Johnson	39	Big game hunting, 443 **acres**.
Columbine Ski Area	40	Lift capacity 2,100 persons/hr., 200 acres, 700 skiers/day and 2 double chair lifts. (Not operating during 1974 and 1975 season).
Circle 4 Ranch	41	Big game hunting, 5 acres.
Triangle Three	42	Big game hunting, 280 acres. Dude ranch, 6 guest. Horseback riding, 10 miles trails, 6 rentals.
Elk River Guest Ranch	43	Dude ranch, 80 acres, 20 guest. Horseback riding, 20 mile trails. Picnicking, 2 acres, 3 tables. Vacation camping, 2 acres and 3 vehicle sites.

Recreation

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Vista Verde	44	Dude ranch, 6 guests. Big game hunting, 885 acres.
Dean Chew	45	Big game hunting, 3,700 acres.
Elk River Recreation	46	Dude ranch, 10 acres.
Elk River Grazing Assoc.	47	Big game hunting, 5,730 acres.
Big Creek Reserve	48	Dude ranch, 10 guests. Big game hunting, 895 acres. Fishing, 3 acres, 2 ponds. Shooting stocked game, 1 acre. Trails, 4 miles.
S-S Ranch	49	Dude ranch, 10 guests. Big game hunting, 2,767 acres.
William Hellyer	50	Big game hunting, 147 acres.
Ski Town KOA Campground	51	Transient camping, 18 acres, 75 vehicle sites and 18 tent sites.
Ray Bunn	52	Big game hunting, 1,300 acres.
Gary A. Kihlstrom	53	Big game hunting, 5 acres. Horseback riding, 20 miles trails 10 rentals.
Steamboat Health and Recreation Association	54	Swimming pool, 7,000 sq. ft. 2 tennis courts.
Fish Creek Falls	55	Picnicking, 6 tables. Bicycling trails, 3 miles.
Fish Creek Park LTD	56	Transient camping 10 acres, 16 vehicle sites, and 16 tent sites.
Steamboat Ski Area, Steamboat Village Resort	57	Snow skiing, 3,500 acres, 6,000 skier/hr. lift capacity. Tennis, 8 courts. Regulation golf course, 170 acres, 18 holes. Horseback riding, 60 miles trails, 40 rentals. Snowmobiling, 200 acres, 20 miles trails.

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Storm Meadows	58	Recreation resort, 20 acres, 200 guests. Three tennis courts. Swimming pool, 5,000 sq. ft.
Scandinavian Lodge	59	Recreation resort, 16 acres, 40 guests. Two tennis courts.
Green Acres	60	Big game hunting, 2,170 acres.
The Timbers	61	Recreation resort, 466 acres, 100 guests. Ten tennis courts. Fishing, 1 pond, 1 acre. Horseback riding, 3 miles trails, 15 rentals. Swimming pool, 5,000 sq. ft.
Louis Wyman	62	Shooting stocked game, 2,000 acres.
Robert Gay	63	Big game hunting, 1,729 acres.
Bruce Henderson	64	Big game hunting, 2,000 acres.
Oak Creek Rodeo and Recreation Junction	65	Rodeo grounds, 5 acres.
Dan Knott	66	Big game hunting, 4,673 acres.
Stagecoach Ski Area	67	Snow skiing, 5,000 skiers/hr., 3,500 acres. Four tennis courts. Fishing, 2 acres, 1 lake. Horseback riding, 60 miles trails, 40 rentals. Snowmobiling, 200 acres, 20 miles trails. (Not operating during 1974 and 1975 season).
R. H. Mile	68	Big game hunting, 1,520 acres.
Eagle Rock Lake	69	Dude ranch, 290 acres, 25 guests. Fishing ponds, 50 acres, 4 ponds. Big game hunting, 290 acres. Non-motorized boating, 5 rentals. Hiking trails, 2 miles.

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Mt. Elim Bible Camp	70	Day camping, 40 acres, 80 guests. Picnicking, 10 acres, 3 tables.
Clyncks Ranch	71	Dude ranch, 1,087 acres, 5 guests. Vacation camping, 2 acres, 2 vehicle sites. Picnicking, 2 acres, 2 tables. Horseback riding, 5 miles trails, 5 rentals.
Flattop Wilderness Ranch	72	Dude ranch, 581 acres, 40 guests. Vacation camping, 6 acres, 12 vehicle sites, 5 tent sites.
Egeria Roping Club	73	Rodeo grounds, 5 acres.
Kelly Klumker	74	Fishing ponds, 5 acres, 1 lake. Big game hunting, 2,500 acres.
In Rio Blanco County:		
Harry Jorden	75	Big game hunting, 5,580 acres. Recreation resort, 10 guests. Pack-in camping, 1 acre. Horseback riding, 10 mile trails, 10 rentals.
Sizemore's Resort	76	Big game hunting, 160 acres. Recreation resort, 20 guests. Pack-in camping, 4 areas. Horseback riding, 1 mile trails, 25 rentals, 10 horses boarded.
Windy Bill Ranch	77	Big game hunting, 80 acres. Recreation resort, 10 guests. Snowmobiling, 80 acres. Fishing, 5 acres, 3 ponds.
Buford Lodge	78	Big game hunting, 220 acres. Archery, 1 range. Picknicking, 10 acres, 8 tables. Recreation resort, 20 guests. Horseback riding, 1 mile trails, 10 guests. ORV trails, 2 miles. Vacation camping, 5 vehicle sites. Fishing, 10 acres, 1 pond. Pack-in camping, 2 areas.
Elwood Livingston	79	Big game hunting, 1,255 acres. ORV trails, 3 miles. Recreation resort, 9 guests. Fishing, 6 acres, 5 ponds.

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
White River Ranch	80	Big game hunting, 4,244 acres. Recreation resort. 15 guests.
Sleepy Cat Guest Ranch	81	Big game hunting, 140 acres. Horseback riding, 3 miles trails, 8 rentals. Snowmobiling and ORVs, 1 mile trails. Pack-in camping, 2 areas.
Nick Mahlares	82	Big game hunting, 4,001 acres. ORV trails, 10 miles.
Dean Chambers	83	Big game hunting, 14 acres. Recreation resort, 14 guests. Pack-in camping, 3 areas. Fishing, 3 acres, 1 pond.
Roy Thompson	84	Big game hunting, 1,348 acres. Recreation resort, 8 guests. ORVs, 10 miles trails.
Robert Dearman	85	Big game hunting, 57 acres. Recreation resort, 40 guests. Fishing, 1 acres, 1 pond. Snowmobiling, 1 mile trails.
Buckhorn Guest Ranch	86	Big game hunting, 10 acres. Recreation resort, 12 guests. Pack-in camping, 3 areas. ORVs, 10 miles trails. Fishing, 10 acres, 1 pond.
Adams Lodge	87	Big game hunting, 160 acres. Recreation resort, 30 guests. Fishing, 4 acres, 2 ponds. Pack-in camping, 2 areas. Horseback riding, 1 mile trails, 30 rentals.
Lee Watson	88	Big game hunting, 6,962 acres. Recreation resort, 15 guests. ORVs, 8 miles trails.
Delbert Pollard	89	Big game hunting, 3,200 acres. ORVs, 5 mile trails.
Evenson Ranch	90	Big game hunting, 120 acres. Recreation resort, 20 guests. Dude ranch, 10 guests.
Welle Guest Ranch	91	Transient camping, 15 acres, 6 vehicle sites. Vacation camping, 3 vehicle sites. Recreation resort, 27 guests.

Recreation

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Elry Kincher	92	Big game hunting, 2,043 acres. Recreation resort, 20 guests. ORVs, 5 miles trails.
Jim Steele	93	Big game hunting, 2,500 acres. Recreation resort, 10 guests. ORVs, 4 miles trails.
Russell Cabins	94	Recreation resort, 5 acres, 20 guests.
Jack Russell	95	Big game hunting, 4,661 acres. Recreation resort, 12 guests. ORVs, 7 miles trails.
Nick Theos	96	Big game hunting, 10,087 acres. ORVs, 21 miles trails. Fishing, 4 acres, 1 pond.
Mike Theos	97	Big game hunting, 3,608 acres. ORVs, 7 miles trails.
Dean Parr	98	Big game hunting, 1,062 acres. ORVs, 3 miles trails.
Sombrero Ranch	99	Big game hunting, 1,100 acres. Pack-in camping, 4 areas. Trails, 4 miles (2 ORV).
John Jump	100	Big game hunting, 220 acres. ORVs, 2 miles trails.
Elmer Mack	101	Big game hunting, 640 acres.
Gus Charchalis	102	Big game hunting, 1,920 acres. Horseback riding, 2 miles trails 4 rentals. Recreation resort, 5 guests.
Doug Wellman	103	Big game hunting, 3,380 acres. Recreation resort. 10 guests.
Lewis Livingston	104	Big game hunting, 6,645 acres. Fishing, one acre, one pond. ORVs, 8 miles trails.

Recreation

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Bert Rosenlund	105	Big game hunting, 2,627 acres. Pack-in camping, 4 areas. ORVs, 2 miles trails.
Pat Sullivan	106	Big game hunting, 1,080 acres. Recreation resort, 12 guests. Fishing, 2 acres, 3 ponds. ORVs, 2 miles trails.
Robert Wells	107	Big game hunting, 5,000 acres. Recreation resort, 30 guests. ORVs, 8 miles trails.
Jim Dodo	108	Big game hunting, 6,536 acres. ORVs, 6 miles trails.
Stagecoach Park	109	Transient and vacation camping, 27 acres plus 16 vehicle and 6 tent sites for each type. Fishing, 5 acres, 2 ponds. Picnicking, 6 tables. Boating, 2 rentals.
Rimrock Gunshop & Campground	110	Transient camping, 2 acres, 15 vehicle sites. Vacation camping, 5 vehicle sites. Picnicking, 4 tables. Shooting range, 20 positions.
Pete Ottoson	111	Big game hunting, 4,068 acres. Recreation resort, 22 guests. ORVs, 15 miles trails.
Bob Peters Ranch	112	Big game hunting, 1,529 acres. Recreation resort, 12 guests. ORVs, 3 miles trails.
Ute Lodge	113	Big game hunting, 312 acres. Recreation resort, 20 guests. Hiking trails, 5 miles. Horseback riding, 2 miles trails, 30 rentals. Pack-in camping, 2 areas. Archery range, 1 position.
Bob Crawford	114	Big game hunting, 4,647 acres. ORVs, 4 miles trails.
Eloise Bailey	115	Big game hunting, 4,712 acres. Recreation resort, 40 guests. ORVs, 7 miles trails.

Recreation

TABLE X-6 (Cont.)

Name	No.	Activity-Facility
Red Thomas	116	Big game hunting, 7,389 acres. Recreation resort, 45 guests. ORVs, 11 miles trails.
Roy McKee	117	Big game hunting, 640 acres. Recreation resort, 5 guests. Horseback riding, 2 miles trails, 5 rentals.
Don Ward	118	Big game hunting, 6,000 acres. Recreation resort, 25 guests. ORVs, 5 miles trails.
K/K Ranch	119	Big game hunting, 13,747 acres. Recreation resort, 10 guests. Fishing, 4 acres, 1 pond. ORVs, 14 miles trails.
B.P.O.E. - Gun Club	120	Shooting range, 20 positions.
White River Bowmen Club	121	Archery Range, 20 positions.

SOURCE: U.S. Soil Conservation Service; NACD Inventory of Private Recreation Facilities, Steamboat Springs, Craig and Meeker, 1974.

TABLE X-7

Sportmans's Club Leases

Name	Leaseholder	Acreage	Activity-Facility
Martin Bros.	ASC[1/]	5,000	Antelope hunting.
Buck Mtn. and the Chow Ranch	ASC	5,000	Elk and deer hunting. Camping and bow hunting.
Elk River	ASC	3,700	Excellent fly fishing. Deer and elk hunting plus bow hunting.
Yampa River	ASC	--	Good fishing and camping.
Blacktail	ASC	--	Deer and elk hunting. Camping.
Winslett - Zingheim	ASC	--	Deer and elk hunting. Camping.
Moffat Co. Unit 'A'	ISC[2/]	--	Excellent antelope hunting. Deer and sage grouse hunting.
Moffat Co. Unit 'B'	ISC	--	Excellent antelope hunting. Deer, coyote, and sage grouse hunting.
Toponas	ISC	--	Deer and elk hunting. Bear and mountain lion in the area. Two base camps.

[1/] American Sportsman's Club
[2/] International Sportsman's Club

SOURCES: American Sportsman's Club 1975.
International Sportsman's Club 1975.
Bureau of Land Management, Craig District Office, Williams Fork URA-MFP 1974.

TABLE X-8

Routt National Forest Recreation-Use by Kinds of Sites

Kind of Site	1974 Visitor Days	1974 % of Total	1969 Visitor Days	1969 % of Total	Average Annual % of Change
General undeveloped areas	176,500	27.1	95,700	27.9	+ 13.02
Roads recreation	130,800	20.1	31,800	9.3	+ 32.69
Winter sports sites	128,400	19.7	50,000	14.6	+ 20.76
Campgrounds	103,200	15.9	80,100	23.3	+ 5.20
Trails recreation	37,500	5.8	23,000	6.7	+ 10.27
Rivers - streams	23,500	3.6	17,700	5.2	+ 5.83
Lakes - ponds	19,300	3.0	19,700	5.7	- 0.41
Reservoirs - impoundments	18,400	2.8	8,600	2.5	+ 16.43
Recreation residence sites	5,700	0.9	5,300	1.5	+ 1.47
Picnic grounds	3,600	0.6	6,500	1.9	- 11.15
Organization sites (pvt)	1,600	0.2	1,600	0.5	+ 0.00
Observation sites	1,500	0.2	3,100	0.9	- 13.51
Boating sites	1,000	0.2	500	0.1	+ 14.87
Total	651,000	100.0	343,600	99.8	+ 13.63

* Compounded annually

SOURCE: Routt National Forest, Recreation Information Management System, 1969 and 1974.

Recreation

TABLE X-9

White River National Forest Recreation-Use by Kinds of Sites
(Blanco Ranger District Only)

Kind of Site	1974 Visitor Days	1974 % of Total	1969 Visitor Days	1969 % of Total	Average Annual % of Change*
General undeveloped areas	118,500	48.2	110,200	48.2	+ 1.46
Roads recreation	41,400	16.8	38,800	16.9	+ 1.31
Campgrounds	33,200	13.5	24.700	10.8	+ 6.09
Lakes - ponds	24,100	9.8	21,100	9.2	+ 2.69
Trails recreation	12,000	4.9	9,100	3.9	+ 5.69
Rivers - streams	6,500	2.6	6,000	2.6	+ 1.61
Rec. residence sites	4,800	2.0	4,900	2.1	- 0.41
Hotel, lodge, resort (pvt.)	4,500	1.8	12,400	5.4	- 18.35
Reservoirs - impoundments	1,100	0.4	1,300	0.5	- 3.29
Total	246,100	100.0	228,500	99.9	+ 1.50

* Compounded annually

SOURCE: White River National Forest, Recreation Information Management System, 1969 and 1974.

TABLE X-10

Dinosaur National Monument Public Use Statistics

Location	Visitors 1973	Visitors 1969	% Average Annual Increase: 1969-1973[1]
Quarry Entrance Rd. (Utah)	279,730	226,028	+ 5.46
Harpers Corner Rd.	39,591	46,058	- 3.71
Headquarters Bldg.	49,325	47,012	+ 1.21
Elk Springs Rd.	1,780	1,401	+ 6.17
Deerlodge Rd.	7,847	2,124	+ 38.64
Lodore	5,884	2,841	+ 19.96
Island Park	7,613	6,588	+ 3.68
Private Boats	3,874	2,548	+ 11.04
Concession Boats	12,614	3,192	+ 40.99
Organized Groups	4,465	---	---
Total Visitors	412,723	337,792	+ 5.14
Total Visitor Days	142,821[2]	103,914	

[1] Compounded annually

[2] Assuming a 12-hr. visitor-day

SOURCE: Dinosaur National Monument, unpublished public use statistics, 1969-1973.

TABLE X-11

1973 Small Game - Waterfowl Hunting Pressure

	Routt				Moffat				Rio Blanco				Species Totals	
	No. Hunters	% of Total*	No. Days	% of Total*	No. Hunters	% of Total*	No. Days	% of Total*	No. Hunters	% of Total*	No. Days	% of Total*	No. Hunters	No. Days
Duck	179	3.8	--	--	171	1.5	--	--	71	1.5	--	--	421	--
Goose	--	--	--	--	121	15.3	--	--	--	--	--	--	121	--
Dove	158	0.5	615	0.4	95	0.3	308	0.2	63	0.2	308	0.2	316	1,231
Pheasant	--	--	--	--	--	--	--	--	51	0.1	140	0.1	51	140
Bobwhite Quail	--	-	--	--	--	--	--	--	43	1.2	40	0.4	43	40
Sage Grouse	557	11.9	1,106	10.8	1,260	26.9	2,406	23.5	112	2.4	235	2.3	1,929	3,747
Blue Grouse	859	8.2	3,301	12.0	31	0.3	83	0.3	283	2.7	715	2.6	1,173	4,099
Cottontail Rabbit	153	0.4	472	0.2	841	2.2	1,887	0.8	803	2.1	5,660	2.4	1,799	8,019
Snowshoe Hare	224	3.4	667	1.8	73	1.1	113	0.3	224	3.4	1,879	5.0	521	2,669
Snipe	41	11.1	74	5.7	--	--	--	--	41	11.1	740	57.1	82	814
Coyote	--	--	--	--	115	0.7	336	0.2	296	1.8	25,188	15.0	411	25,524
County Totals	2,171		6,245		2,707		5,133		1,987		34,905			

* % of total for State of Colorado.

SOURCE: Colorado Division of Wildlife, 1973 Small Game Harvest Report.

Recreation

TABLE X-12

Big Game Hunting Pressure - 1973

Species and Type of Hunt	Measuring Parameters	Game Management Unit 1	2	3	4	5	10	11	12	13	14	15	23	24	26	441
Deer, Regular Season	No. hunters:	434	2,285	4,842	2,610	1,152	1,079	5,313	1,181	2,006	1,143	1,361	2,059	551	725	529
	Resident	171	861	2,936	1,679	845	565	2,741	765	1,426	866	1,131	1,249	397	583	430
	Non-Resident	263	1,424	1,906	931	307	514	2,572	416	580	277	230	810	154	142	99
	Hunters/mi.^{2}	3.71	1.66	3.59	5.30	3.72	1.30	6.21	2.64	2.61	2.06	2.81	4.65	1.18	3.22	2.35
	Hunter-days*	1,493	9,541	15,336	8,274	3,673	3,715	17,474	3,947	7,211	3,877	4,626	8,084	2,666	2,724	1,350
Deer, Archery	No. hunters:	6	61	91	157	144	43	112	105	260	279	143	239	92	48	44
	Resident	-	29	72	109	118	17	55	66	213	215	127	115	63	41	31
	Non-Resident	6	32	19	48	26	26	57	39	47	64	16	124	29	7	13
	Hunters/mi.^{2}	.05	.04	.07	.32	.46	.05	.13	.23	.34	.50	.30	.54	.20	.21	.20
	Hunter-days	39	252	508	879	744	263	542	657	1,504	1,271	711	1,405	403	205	242
Elk, Regular Season	No. hunters:		291		1,658	1,101		567	1,981	3,660	2,153	1,584	2,330	1,036	827	312
	Resident		250		1,112	884		288	1,383	2,700	1,762	1,369	1,565	838	669	248
	Non-Resident		41		536	217		279	598	960	391	215	765	198	158	64
	Hunters/mi.^{2}		1.37		3.37	3.55		0.66	4.42	4.75	3.88	3.27	5.26	2.21	3.68	1.39
	Hunter-days*		1,055		6,832	4,715		2,197	8,549	17,451	9,748	7,528	13,217	5,433	4,248	1,058
Elk, Archery	No. hunters:		2	3	161	61		78	91	193	112	79	151	110	64	17
	Resident		2	-	69	33		33	63	158	46	67	50	66	45	14
	Non-Resident		-	3	92	28		45	28	35	66	12	101	44	19	3
	Hunters/mi.^{2}		0.00	0.00	0.33	0.20		0.09	0.20	0.25	0.20	0.16	0.34	0.24	0.28	0.08
	Hunter-days		6	18	1,008	404		520	536	1,210	605	388	1,000	628	359	58
Bear	* Hunter-days	123	24		82	67	20	60	207	197	169	94	313	27	20	
Antelope	** No. hunters	26	168	740	17	240										
	Resident	23	161	726	17	230										
	Non-Resident	3	7	14	-	10										
	Hunter-days	40	219	962	26	281										

* This data compiled by big game management units, (see Figure RIV-30).
** This data compiled by antelope game management units, (see Figure RIV-31).

SOURCE: Colorado Division of Wildlife, 1973, Big Game Harvest Report.

TABLE X-13

Big Game Hunter Residence - 1973
Resident Deer Hunters

	Game Management Unit														
Planning Region	1	2	3	4	5	10	11	12	13	14	15	23	24	26	441	Total
1	8	0	35	9	8	0	17	0	17	34	17	0	9	0	18	172
2	8	42	177	143	101	33	169	59	92	41	42	109	42	25	41	1,124
3	50	396	1,602	1,065	576	152	1,537	368	574	423	726	684	220	364	220	8,957
4	9	25	92	42	59	42	203	67	50	42	59	85	25	42	26	868
5	0	0	8	16	0	0	8	0	8	9	8	16	8	0	0	81
6	0	9	17	0	0	0	25	0	0	0	0	0	0	0	0	51
7	0	0	0	0	0	9	34	8	9	0	8	0	0	8	0	76
8	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	25
9	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	17
10	0	0	26	8	24	8	25	0	17	0	0	9	0	8	8	133
11	85	321	852	346	35	304	505	80	270	50	25	319	59	17	0	3,368
12	0	59	110	42	42	17	68	26	380	253	237	9	34	119	117	1,513
13	0	9	17	8	0	0	34	0	9	0	9	18	0	0	0	104
Other	11	0	0	0	0	0	91	40	0	14	0	0	0	0	0	156
Total	171	861	2,936	1,679	845	565	2,741	756	1,426	866	1,131	1,249	397	583	430	16,645

Recreation

TABLE X-14

Big Game Hunter Residence - 1973
Non-Resident Deer Hunters

	Game Management Unit															
State	1	2	3	4	5	10	11	12	13	14	15	23	24	26	441	Total
Alabama	11		11	11									11			44
Arizona			11				11	11	11			33				77
Arkansas	22	11	33				33	11	33	11	11				11	176
California	22	482	613	225	33	295	735	87	98	88	33	230	45		23	3,009
Delaware		11														11
Florida	22	10	22	11	11	22	32		11			11				152
Georgia					11				11							22
Illinois	11	77	77	44	11		110		22		11	22		11	11	407
Indiana		22	55	11	10	22	88	11	11	43		21			10	304
Iowa	11	11	43				33									98
Kansas			11	22			120	22	11		11			11		208
Kentucky		11	33							11	22	11		11		99
Louisiana	11	44	22				33	11				11	11			143
Maine			11													11
Maryland		11	11	11									11			44
Massachusetts			22													22
Michigan	22	65	142	128	44	11	208	110	44	22		88	10			894
Minnesota		22	55				44	11								132
Mississippi		11	22	55	22		22									132
Missouri	10	88	77	55	22	11	142		33			66	22	11	11	548
Montana			22													22

TABLE X-14 (Cont.)

Big Game Hunter Residence - 1973
Non-Resident Deer Hunters

	Game Management Unit														
State	1	2	3	4	5	10	11	12	13	14	15	23	24	26	441	Total
Nebraska				21			22					11				54
New Jersey			11				11									22
New Mexico					11		11									22
New York		22	10			22							11			65
North Carolina		10	22								32					64
Ohio	33	88	143			10	33	22	10	22		10		33		404
Oklahoma		33	33	11			65				22	22	11	11	11	219
Oregon		11		11					11							33
Pennsylvania	11	11	131	33	11	11	176	21	22	11						438
South Dakota							11									11
Tennessee		33	88				11	22				11				165
Texas	66	231	87	118	66	66	416	66	186	33	33	132	11	54		1,565
Utah	11	43		65		33										152
Virginia		22										32				54
Washington									22			11			11	44
West Virginia			11				11			11					11	44
Wisconsin		44	88	77	55	11	175	11	44	22	55	88	11			681
Wyoming			11				11									22
Total	263	1,424	1,906	931	307	514	2,572	416	580	277	230	810	154	142	99	10,625

* Species seasons -- total non-resident hunters.

TABLE X-15

Big Game Hunter Residence - 1973
Non-Resident Elk Hunters

	Game Management Unit														
State	1	2	3	4	5	10	11	12	13	14	15	23	24	26	441	Total
Alaska										1						1
Arizona					1				1	1		19				22
Arkansas				8			16	32	8	32	16	20	19	16		167
California		13		83	32		50	144	67	51	33	181	38	8	2	702
Connecticut				1												1
Washington D.C.													6			6
Florida				17			17		8	3						45
Georgia				9	21		14	8	24	1			7			84
Illinois				8	8		10	18	20	22	24	20	6	8		144
Indiana				8			9	33	25			12		9		96
Iowa				17	2		8	8	32	18		20		8	3	116
Kansas				17	9		8	8	49	35	8	12	19		9	174
Kentucky				8			8	8	8			13	7			52
Louisiana							16	8	8		8			8		48
Maryland					8							7				15
Michigan				75	2		16	11	81	4	25	96	6		9	325
Minnesota		1		8				2	9	46		19			8	93
Mississippi				33				8	8							57
Missouri		3		49	30		10	67	150	3	16	32	7	33	9	409
Nebraska		2			4		8		1	39		39		8		101
Nevada		4							11	9		19	25			68
New Jersey												7				7

TABLE X-16

Big Game Hunter Residence - 1973
Resident Elk Hunters

Planning Region	2	4	5	11	12	13	14	15	23	24	26	441	Total
	Game Management Unit												
1	1	7	30	9	28	79	65	15	17	17	0	0	268
2	14	106	90	23	58	224	222	111	99	51	27	20	1,045
3	72	501	612	119	777	1,435	936	732	936	510	456	134	7,220
4	10	43	29	7	44	79	85	58	84	51	65	19	574
5	0	6	0	0	20	0	5	7	12	6	0	0	56
6	0	0	8	0	0	15	1	13	16	0	7	0	60
7	0	19	0	8	0	15	5	0	12	0	0	0	59
8	2	59	0	0	0	0	1	6	0	0	13	0	81
9	0	0	0	0	0	0	6	0	0	0	0	0	6
10	0	12	0	7	7	6	9	13	11	5	0	7	77
11	130	355	61	115	330	300	71	20	337	187	47	25	1,978
12	21	9	52	0	109	534	323	253	12	11	28	41	1,393
13	0	5	2	0	10	13	33	19	29	0	26	2	139
Other	0	0	0	0	0	0	0	122	0	0	0	0	122
Total	250	1,122	884	288	1,383	2,700	1,762	1,369	1,565	838	669	248	13,078

TABLE X-16 (Cont.)

Big Game Hunter Residence - 1973
Non-Resident Elk Hunters

State	Game Management Unit															
	1	2	3	4	5	10	11	12	13	14	15	23	24	26	441	Total
New Mexico				9					8	8			7			32
New York								16	9						8	33
North Carolina							24									24
North Dakota								8				12				20
Ohio		4		24	8			17	16	13		45	6			133
Oklahoma				8	8			16	50		10	20	13	41		166
Oregon				8												8
Pennsylvania				49	25		8	56	187	16	8	32		1	8	390
South Dakota				8	10				8		16		6			48
Tennessee		4		8	1											13
Texas		9		65	32		56	98	91	51	49	69	20	18	8	566
Utah		1						8	16			7				32
Vermont				8												8
Washington												6				6
West Virginia										1		7				8
Wisconsin				8	8		1	24	65	35		51	6			198
Other*											2					2
Total		41		536	217		279	598	960	389	215	765	198	158	64	4,420

* Special seasons -- total non-resident hunters.

Recreation

TABLE X-17

Fishing Visitor-Use Information for Lakes and Reservoirs in the Study Region

Name of Lake/Reservoir	Acres	Legal Description T	R	Sec	Ownership Status	Fisherman Days/Yr.*
Beaver	8.6	9N	83W	10	Public	100
Big Creek Lake	8.2	8N	83W	-	Public	10
Diana	9.2	11N	83W	-	Public	20
Dinosaur	8.6	6N	83W	-	Public	200
Dome	4.7	8N	83W	4	Public	50
Dunkley	20.0	3N	88W	1	Public	0
Edward	11.8	8N	84W	19	Public	300
Elbert	11.0	8n	83W	-	Private	30
Elmo	10.0	6N	83W	-	Public	500
Farwell	5.0	10N	84W	18	Public	200
Fish Creek Res.	57.0	6N	83W	-	Public	2000 (20 on ice)
Fish Hawk	3.7	8N	84W	29	Public	200
Fish Hook	16.0	6N	83W	-	Public	500
Gardner Park Res.	47.0	1N	86W	14,15,22	Public	200
Gill Res.	7.5	3N	88W	11	Public	0
Gilpin	18.0	10N	83W	-	Public	1000
Gold Creek Lake	7.1	10N	83W	4	Public	300
Hahns Peak	40.0	10N	86W	12	Public	7150 (150 on ice)
Harper Res.	12.0	1N	86W	26, 27	Public	288
Lagunita	3.0	2N	83W	27	Public	250
Lake of the Crags	4.8	8N	83W	-	Public	20
Lake Pearl	167.0	10N	85W	35	Public	12050 (50 on ice)
Long	30.0	6N	83W	-	Public	100
Lost	14.0	6N	83W	-	Public	300
Luna	38.0	8N	83W	-	Public	500
Margaret	33.0	8N	84W	19	Public	500
Mica	5.5	10N	83W	-	Public	200
Mirror	6.4	8N	84W	19	Public	10
North	5.5	9N	83W	21	Public	900
Pristine, Lost Ranger	8.5	8N	83W	3	Public	10
Ptarmigan	7.0	8N	83W	-	Public	10
Quaker Mtn.	1.0	9N	87W	32	Public	12
Rosa	5.7	8N	84W	25	Public	100
Sage Creek Res.	20.0	5N	88W	13	Closed	20
Sanchez Lake (Lower)	4.6	11N	84W	25	Public	4
Sanchez Lake (Upper)	2.8	11N	84W	25	Public	4
Sellers	20.0	3N	88W	1,2	Public	0
Shaffer	20.0	3N	88W	2	Public	0
Snowstorm	8.3	8N	84W	30	Public	200

* Fisherman days are equivalent to activity days.

TABLE X-17 (Cont.)

Name of Lake/Reservoir	Acres	Legal Description T	R	Sec	Ownership Status	Fisherman Days/Yr.*
Steamboat	1083.0	10N	86W	-	Public	28000 (1200 on ice)
Sunnyside Lake #1	5.0	1S	86W	3	Public	75
Sunnyside Lake #2	7.0	1S	86W	3	Public	75
Sunnyside Lake #3	2.5	1S	86W	3	Public	75
Three Island	23.2	9N	83W	-	Public	100
Wolverine	8.5	8N	82W	-	Public	50
Sub-Total for Routt County						56153 (1420 on ice) (86.6% of study area total)
Butch Cassidy	100	10N	104W	12	Public	40
Freeman Res.	14	9N	89W	6	Public	525 (25 on ice)
Hog	51	10N	103W	9	Public	100
Ralph White	40	8N	90W	26	Public	600 (50 on ice)
Sub-Total for Moffat County						1175 (75 on ice) (1.8% of study area total)
Axial Basin Res.	20	4N	93W	13	Private (Public access maintained)	375 (10 on ice)
Avery	263	1S	91W	7,18	Public	2000 (200 on ice)
Allen Basin Res.	20	2N	86W	9	Public	700 (200 on ice)
Chapman Res.	25	3N	86W	31	Public	210 (10 on ice)
Crosho	54	2N	86W	5	Public	750 (150 on ice)
Watson	24	2N	86W	28	Public	75
Killarney	19	2N	87W	12,13	Public	100
Pagoda	7	2N	89W	23	Public	50
Rio Blanco	120	1N	96W	6	Public	500 (400 on ice)
Sherriffs Res.	35	2N	87W	-	Public	160
Sizemore #1	2	1N	90W	21	Private	500 (50 on ice)
Vaughn	36	2N	88W	22	Public	2000
Sub-Total for Rio Blanco County Portion of Study Area						7520 (1020 on ice) (11.6% of study area total)
Grand Total						64848

SOURCE: Colorado Division of Wildlife, 1972 Fisheries Inventory.

Recreation

TABLE X-18

Fishing Visitor-Use Information for Streams

Stream Name	% Open to Public	Est. Fisherman Days/Yr.*
Adams	100	25
Agnes	100	10
Armstrong	100	6
Bear	100	10
Beaver (Walton)**	100	0
Beaver (Williams Fk.)	100	25
Beaver (Willow)	90	400
Big	60	900
N. Fork Big	100	10
Box	100	50
Burn	100	20
Cabin (Big, Elk)	100	10
Cabin	100	10
Chicken	90	25
Chimney	0	4
Circle	100	6
Clear	90	1
Coleman	0	5
Corral	100	2
Cottonwood	30	100
Coulton	90	10
Cranepale	100	50
Crawford	100	15
Day	10	0
Deep	10	2
Ditch	100	10
Douglas	100	15
Dutch	50	500
Egeria	10	10
N. Fork Elk River	98	1500
Middle Fork Elk River	100	500
S. Fork Elk River	100	500
Elk River #1	20	2000
Elk River #2	99	4000
Elkhead	100	10
Dry Fork Elkhead	100	0
N. Fork Elkhead	100	10
Middle Fork Elkhead	100	50
English	100	20
Finger Rock	0	10
S. Fork First	100	50
Middle Fork First	100	10
West Fork Fish	100	4
Fishook	100	50
Floyd	20	3
Gilpin	100	1000
Goldcreek	100	2000
Granite	100	50
Green Creek	95	50
Grizzle	50	50
Gunn	100	0
Harrison	95	50
Hinman	80	200
Hole-in-wall	100	6
Horse	100	20
Hot Spring	50	0
Hunt	0	30
Middle Fork Hunt	10	15
South Fork Hunt	60	20
North Fork Hunt	0	10
Independence	90	75
Indian Run	100	20
Johnson	100	10
King	0	20
King Solomon	100	200
Knowles	100	6
Larson	50	1500

* Fisherman days are equivalent to activity days (participation for all or part of one day).

**Parenthetical insertions denote drainages when duplicate names occur.

TABLE X-18 (Cont.)

Stream Name	% Open to Public	Est. Fisherman Days/Yr.*
Lester	100	1000
Little Red Park	100	30
Lopez	100	10
Lost Dog	100	20
Mad	70	200
Middle Fork Mad	100	50
S. Fork Mad	100	50
Mlkinnis	80	0
Mica	100	150
Middle	60	0
Mill (Steamboat Lake)	100	300
Mill (Dry Fk. Elkhead)	0	10
Miller	10	3
Morrison	30	100
Muddy	10	2
Oak	80	200
Oliver	100	10
Phillips, Chimney Rock	40	100
Porcupine (Mad)	100	1
Porcupine (Little Rock)	100	25
Priest	50	0
Red	50	5
Reed	80	10
Renfro	10	2
Roaring Fork	100	30
Rock (Elk River)	80	2
Little Rock (Big Rock)	100	50
Sanchez	100	3
Sand	70	10
Sawmill	100	6
Scotts Run	100	30
Second	5	0
Shoe and Stocking	100	100
Silver City	100	75
Slater	50	300
Smith (Deep)	80	70
Smith (Independence)	30	2
Little Snake River #1, (below Willow Creek)	0	75
Little Snake River #2, (above Willow Creek)	50	250
Middle Fk. Snake River	90	200
South Fk. Snake River	33	25
Soda	100	100
Spring	80	300
Stormking	100	0
Stukey	100	6
Summit	100	75
Teepee	100	25
Three Island	100	100
Torso	100	10
Tow	0	10
Trail	100	150
Little Trout	50	0
Walton	90	500
South Fork Walton	100	50
Watson	0	30
Whiskey (Big Rock)	100	15
Whiskey (M. Fk. L. Snake)	100	150
Williams Fork	100	50
S. Fork Williams Fork	100	20
Willow (Elk R.)	99	1200
Willow (L. Snake R.)	0	10
Wolverine	100	500
Yampa River (Elkhead Creek to Mt. Harris)	-	-
Yampa River (Mt. Harris to Service Creek)	-	-
Yampa (segment from Service Creek to Bear River)	60	1000
Sub-Total for Routt County (53.9% of study area total)		24087

TABLE X-18 (Cont.)

Stream Name	% Open to Public	Est. Fisherman Days/Yr.*
Little Bear	40	350
Beaver (Green River)	100	140
Beaver (Slater)	100	15
Cottonwood	70	300
Deer	100	10
Fortification	70	200
Green River	90	1200
Lynch	100	10
Roaring Fork Slater	100	20
Little Snake (below Colo. 318 crossing)	100	50
Little Snake (Wyo. to Powder Wash)	100	75
Snell Rock	100	10
Talamantes	100	25
Willow	95	30
Yampa River (Utah to Maybell)	90	300
Yampa River (Maybell to Elkhead Creek)	50	1,000
Sub-total for Moffat County (8.4% of study area total)		3,765
Big Beaver Creek	30	100
Black Mountain	100	12
Blue Mountain	100	2
Bunker	50	10
Coal	0	12
Corral	100	10
Cyclone	100	15
East Fork Beaver	100	6
Fawn	80	25
Fish	50	0
Lost	100	0
Moody	100	5
Morapos	100	20
Pagoda	100	15
Pine	100	10
Poose	100	20
Ripple	100	100
Rough	100	10
Slide	100	25
Snell	100	100
Trout	80	200
White River (Utah to Strawberry Ck. confluence)	5	100
White River (Strawberry to Buford)	10	10,000
N. Fork White River	10	5,000
S. Fork White River	50	1,000
E. Fork Williams Fork R.	100	50
Sub-Total for Rio Blanco County (37.7% of study area total)		16,857
Grand Total		44,709

SOURCE: Colorado Division of Wildlife, 1972 Fisheries Inventory.

Recreation

TABLE X-19

1974 Fishery Questionnaire - User Origin

Region of Residence	Region Fished					
	Stream Fishing		Lake Fishing		Streams & Lakes Combined	
	11	12	11	12	11	12
1	5	75	13	58	18	133
2	24	307	23	397	47	704
3	522	3340	614	4835	1130	8175
4	6	100	32	144	38	244
5	0	0	1	28	1	28
6	0	6	0	5	0	11
7	28	45	36	23	64	68
8	4	0	0	18	4	18
9	6	9	0	13	0	22
10	57	8	105	3	162	11
11	1367	332	1212	152	2579	484
12	80	1305	47	577	127	1882
13	21	23	0	25	21	48
Resident Totals*	2120	5550	2083	6278	4203	11823
% of Total for State	9.19	24.05	6.38	19.23	7.54	21.23
Non-resident totals*	304	878	328	602	632	1475
% of Total for State	5.00	14.34	7.18	13.18	5.93	13.85
Totals in Region*	2424	6428	2411	6880	4835	13298
% Resident	87.5	86.3	86.4	91.2	86.9	88.9
% Non-resident	12.5	13.7	13.6	8.8	13.1	11.1

* Reported by numbers of fishermen.

SOURCE: Colorado Division of Wildlife, 1974 Fisheries Questionnaire.

Social Environment and Economic Conditions

Recreation

TABLE 5-24

1974 Fishery Questionnaire - User Origin

Region of Residence	Region Fished					
	Stream Fishing		Lake Fishing		Streams + Lakes Combined	
	71	72	71	72	71	72
1	5	78	13	88	18	175
2	25	387	42	322	67	709
3	930	3940	629	4832	1560	8772
4	10	100	36	164	46	264
5	0	9	0	20	0	29
6	0	8	0	4	0	12
7	10	47	58	21	68	68
8	0	0	0	10	0	10
9	0	0	0	12	0	12
10	0	7	102	4	102	11
11	1067	302	1312	152	2379	454
12	300	1021	47	1423	347	2444
13	31	22	0	22	31	44
Resident Totals*	2130	5033	2041	4378	4209	10411
% of Total for State	5.1%	14.0%	6.3%	16.2%	5.6%	15.1%
Non-Resident Totals*	308	972	328	402	636	1375
% of Total For State	5.7%	14.1%	7.1%	12.1%	5.8%	13.4%
Totals in Region*	2438	6428	2411	4880	4845	12845
% Resident	87.3	84.3	86.4	91.2	86.9	87.8
% Non-resident	12.7	15.7	13.6	8.8	13.1	12.2

* Reported by numbers of fishermen.

APPENDIX D

TABLE OF CONTENTS
FOR
SOCIAL ENVIRONMENT
AND
ECONOMIC CONDITIONS

Page

Economic Conditions--- XI-1
  Regional Population Employment Model---------------------------- XI-1
  The Population Projection Component----------------------------- XI-14
  Allocation of Project Employment to Place of Residence--------- XI-22
Craig Opinion Survey and Meeker Opinion Survey Questionnaires------- XI-32-45

APPENDIX D

TABLE OF CONTENTS
FOR
SOCIAL ENVIRONMENT
AND
ECONOMIC CONDITIONS

Table	Title	Page
XI-1	Industry Classification Scheme	XI-11-12
XI-2	Employment Coefficients	XI-13
XI-3	One-way Travel Time Matrix	XI-25
XI-4	Direct Employment Matrix	XI-26-27
XI-5	Moffat County Population Projection	XI-28
XI-6	Rio Blanco County Population Projection	XI-29
XI-7	Routt County Population Projection	XI-30-31

Economic Conditions

Regional Population Employment Model

The most frequently used form of regional employment projection model is the export base analysis. Although there are numerous variations of this type of analysis, the most common form is one which utilizes past employment trends to derive an employment multiplier similar to the familiar Keynesian income multiplier. A simple export base model could be represented as:

$$ET = EX + EL$$

$$EL = aEX$$

$$ET = EX + aEX$$

or $\Delta ET = \Delta EX (1.0 + a)$

where

ET is total employment,

EX is export-oriented employment (exogenous),

EL is locally-oriented employment, and

a is a coefficient estimated from a previous time period.

Given an expected level of employment in the export sectors, the multiplier is used to estimate the local service employment and thus the total employment which will occur as a result of a given level of export activity. Most State and local employment projections are based upon an export base analysis similar to the one outlined above. The employment projection model which was used for the Northwest Colorado Coal EIS is a modified export base analysis which has been linked to a cohort-survival population model. This model has been used to estimate total employment and population levels associated with projected levels of construction and operating employment for several potential energy-related industrial developments in the study area. A brief description and background of the working model follows.

A modified export base model

Czamanski (1964) has outlined a more detailed export base model for regional growth which considers the locational aspects of urban employment. For this model, all types of economic activity are divided into geographically-oriented industries, complementary industries, and urban-oriented industries.

Geographically-oriented industries may be defined as:

> ...industries whose main locational factors are geographical or conditioned by the environment. In this group fall extracting industries (resources-oriented), processing industries (industries in which a significant proportion of their labor force is employed in processes depending directly on raw material inputs), industries depending on a large supply of good water, etc., transportation centers, and large establishments employing more than, say, 10,000 workers on one site. By definition, investments in this category of economic activity do not depend on the size and character of urban development (p. 183).

Complementary industries are:

> ...industries for which the main locational factor is the presence of other industries. In this category fall all enterprises producing services or goods for a limited number of large customers (geographically-oriented industries) located in the same urban area (p. 183).

Urban-oriented industries may be defined as:

> ...industries for which the existence of the city is the main locational factor. This category comprises services which cannot be transported, industries using female labor otherwise unemployed, using the urban labor pool and various other facilitires, small establishments for which the possibility of using power supplied by municipal power plants, municipal water, etc. is important. This category includes many more industries than just the market-oriented activities singled out by some other urban-growth models (p. 184).

Based on these definitions, the Czamanski model may be formulated as:

$P = a_1 + b_1 E_T$

$E_T = E_g + E_c + E_u$

E_g = exogenous

$E_c = a_2 + b_2 E_g$

$E_u = a_3 + b_3 P$

where

P is population,

E_T is total employment,

E_g is geographically oriented employment,

E_c is complementary employment,

E_u is urban oriented employment,

a_1, a_2, a_3 are constants estimated from regression analysis, and

b_1, b_2, b_3 are the corresponding coefficients from the regression results.

This set of relationships can be used to calculate an employment multiplier for the region. By substitution:

$$E_T = \frac{E_g + a_2 + b_2 E_g + a_3 + b_3 a_1}{1.0 - b_3 b_1}$$

or

$$\Delta ET = \frac{\Delta E_g + a_2 + b_2 \Delta E_g + a_3 + b_3 a_1}{1.0 - b_3 b_1}$$

An employment model for the study area

In recent years, several large-scale regional modeling efforts have utilized a Czmanski type approach to problems of employment projections

(San Diego County Comprehensive Planning Organization, 1972; Hamilton, et al., 1969; Monarchi, 1974). All of these studies have used an industry determinization scheme similar to the one outlined earlier. The most obvious shortcoming to this approach as it has been used is that the market orientation designation has been mutually exclusive in regard to external trade. For example, complementary industries and urban-oriented industries are assumed to be oriented completely toward the internal markets of the region. As a consequence, imports and exports associated with these industries must be assumed to be zero, or alternatively, they must be assumed to exactly balance each other in each industry (net exports equal zero for each industry). While this problem may not be severe for large urban regions or smaller closed regions, it will definitely impose severe limitations upon the analysis when applied to smaller, more open economies such as counties or rural trading areas. In order to more adequately account for imports and exports in small regions, a more specific treatment of external trade is used for the present model.

Assume that the Czamanski market orientation scheme outlined earlier is valid and applicable to some region under study so that the following identity holds:

$$E_T = E_B + E_{BS} + E_{PS}$$

$$P = B_1 ET$$

where

E_B is basic industry employment which is much the same as the earlier geographically oriented employment. Assume that, as before, these industries are completely market oriented and that their levels are exogenously determined;

E_{PS} is population service employment (similar to urban-oriented employment);

E_{BS} is business-serving employment which is complementary to both basic industry employment and population-serving employment;

P is population; and

E_T is total employment.

In contrast to the usual approach of assuming a completely internal orientation for business-serving employment (E_{BS}) and population-serving employment (E_{PS}), export-oriented employment is included in both industry types so that:

$$E_{BS} = E_{BS}^{L} + E_{BS}^{X}$$

$$E_{PS} = E_{PS}^{L} + E_{PS}^{X}$$

where

L denotes locally oriented employment, and

X denotes export employment.

Based upon these definitions, the following model can be formulated:

$$E_T = E_B + E_{BS} + E_{PS}$$

$$E_B = \text{exogenous}$$

$$E_{BS} = E_{BS}^{L} + E_{BS}^{X}$$

$$E_{BS}^{X} = \text{exogenous}$$

$$E_{PS} = E_{PS}^{L} + E_{PS}^{X}$$

$$E_{PS}^{X} = \text{exogenous}$$

$$P = b_1 \; E_T$$

$$E_{BS}^{L} = b_2 \; (E_B + E_{PS})$$

$$E_{PS}^{L} = b_3 P$$

where

all terms are as defined previously.

The locally oriented business-serving employment (E^L_{BS}) is thus a complementary industry to the basic industry employment in the region (E_B) and also to the population-serving employment (E_{PS}). Note that the business-serving employment locally (E^L_{BS}) must serve not only the locally oriented population-serving employment (E^L_{PS}) but also the export component of population-serving employment (E^X_{PS}). The locally oriented population-serving employment (E^L_{PS}) serves only the resident population of the region (P).

The system of equations above may be solved by substitution to yield:

$$E_T = \frac{E_B\ (1.0 + b_2) + E^X_{PS}\ (1.0 + b) + E^X_{BS}}{1.0 - b_2 b_3 b_1 - b_3 b_1}$$

or

$$\Delta E_T = \frac{\Delta E_B\ (1.0 + b_2) + \Delta E^X_{PS}\ (1.0 + b_2) + \Delta E^X_{BS}}{1.0 - b_2 b_3 b_1 - b_3 b_1}$$

This model is a modified form of the usual economic base approach in which exogenous or export employment is the primary driving force in the local economy. While it seems very likely that exports will provide the main impetus for change in this model framework also, it is not, as with the usual approach, a foregone conclusion. Using these model assumptions, the local economy can change as a result of changes which may occur in the population structure as well as changes in the export base. However, as is the case with all economic base approaches, this model does require that export-oriented employment be separated from total employment and projected to some future time.

Estimating export employment

Since very few economic base studies are actually based upon survey research, several short-cut methods for calculating exports have evolved in recent years. The two most widely known procedures are the location quotient technique (Hirsch, 1973; Leigh, 1970) and the minimum requirements technique (Ullman, et al., 1971).

The procedure for estimating export and local employment for the model developed here is a synthesis of these two approaches. That is, some export employment is estimated based solely upon employment (location quotient) and some estimated as a function of population (minimum requirements). Earlier, a regional employment model was specified. Let us assume a corresponding national model where net exports are essentially zero so that the following relationships describe the system:

$$NET = NEB + NEBS + NEPS$$

$$NEB = \sum_{i=1}^{j} NEB_i$$

$$NEBS = \sum_{i=1}^{k} NEBSi$$

$$NEPS = \sum_{i=1}^{m} NEPSi$$

$$CBSi = NEBSi / (NEB + NEPS)$$

$$CPSi = NEPSi / NP$$

where

NET, NEB, NEBS, NEPS, and NP represent national values for employment and population which correspond to the regional definitions and the subscript i represents the individual industries which make up the three employment groups,

CBSi is a coefficient which shows the relationship between employment in business-serving industry i and the total employment in basic and population-serving employment, and

CPSi is a coefficient which identifies the relationship between employment in population-serving industry i and the total population.

Assume that base year employment and population values are available for the region so that EBi's, EBSi's and EPSi's are known. Regional values for the national relationships could be calculated as:

DBSi = REBSi / (REB + REPS)

DPSi = REPSi / RP

where

DBSi and DPSi represent actual observed relationships in the region for the base year.

Since the observed regional values (i.e., DBSi and DPSi) reflect local imports and exports, these values will likely differ significantly from the national values (CBSi and CPSi), which reflect only current technology. A regional employment requirement then would be given by:

RREBSi - CBSi · (REB + REPS)

RREPSi = CPSi · RP

where

RREBSi is the required regional employment in regional business-serving industry i, and

RREPSi is the required regional employment in regional population-serving industry i.

Net export employment for each industry in the region for the base year would be:

XREBSi - RREBSi - REBSi

XREPSi - RREPSi - REPSi

where

XREBSi and XREPSi are net export employment for the region for a particular industry i, and

REBSi and REPSi are the observed values for regional industries for the base year.

A negative net export value would thus indicate imports and a positive value would identify exports. Since imports represent an inability of the regional system to fully capture employment effects, an allowance must be made for this propensity to import. Thus for each industry which has a negative net export (i.e., imports), the actual employment requirement which exists in the region is less than the total employment requirement which was calculated using the national relationships. For each industry which has positive net exports, the total employment requirement is identical to the requirement calculated from the national relationships.

The actual employment requirements for each industry in the region are thus calculated as:

$$ARREBSi = \{\min (CBSi, DBSi)\} \cdot (REB + REPS)$$

$$ARREPSi = \{\min (CPSi, DPSi)\} \cdot RP$$

where

ARREBSi is the actual required regional employment in business-serving industry i,

ARREPSi is the actual required regional employment in population-serving industry i,

min (CBSi, DBSi) is the lesser of CBSi and DBSi, and

min (CPSi, DPSi) is the lesser of CPSi and DPSi.

These actual employment requirements thus represent the employment relationships which are present in the regional system. The propensity to import has been identified and the base year values for export employment have been estimated. (Note that this model formulation does not preclude a variable propensity to import.) The employment model is completed as follows:

$$b_2 = \sum_{i=1}^{k} \{\min (CBSi, DBSi)\}$$

$$b_3 = \sum_{i=1}^{m} \{\min (CPSi, DPSi)\}$$

$$REBS = b_2 (REB + REPS) + XREBS$$

$$REPS = b_3 (RP) + XREPS$$

where

XREBS and XREPS are now the values for export regional employment (only the positive net exports).

With the calculation of the b_2 and b_3 values and the base year export employment, the employment model is identical to the model specified in the previous section. The industry classification scheme and the coefficient values used for the model are shown in Tables XI-1 and XI-2.

TABLE XI-1 - Industry Classification Scheme

Basic Industries

Industry description	S.I.C.
Agriculture	01,07-09
Mining	10-14
Furniture, lumber and wood products	24-25
Metal industries	19, 33-34
Machinery, except electrical	35
Electrical machinery	36
Transportation equipment	37
Other durable goods	32, 38-39
Food and kindred products	20
Textiles and textile products	22-23
Chemical and allied products	28
Other non-durable goods	21, 26, 29-31
All transportation	40-47
Wholesale trade	50
Federal government	91

Business-Serving Industries

Industry description	S.I.C.
Construction	15-17
Printing and publishing	27
Communications	48
Utilities and sanitary services	49
Business and repair services	73-76
Legal, engineering, and misc. professional services	81, 89

Population-Serving Industries

Industry description	S.I.C.
Food, bakery, and dairy stores	54
Eating and drinking places	58
General merchandise retailing	53
Motor vehicles sales and service stations	55
Other retail trade	52, 56-59
Finance, insurance, and real estate	60-67
Personal services	70, 72, 88

TABLE XI-1 - Industry Classification Scheme (Cont'd)

Industry description	S.I.C.
Entertainment and recreation services	78-79
Hospitals and health services	80
All education	82, 84
Welfare, religious and non-profit services	86
Public administration, except federal	92-93

TABLE XI-2 Employment Coefficients

Coefficient	National	Moffat County	Rio Blanco County	Routt County
b_1 (1970)	2.64142	2.60687	2.48818	2.60863
b_2[2]	.19459	.16339	.15659	.16465
b_3[2]	.17268	.15291	.14916	.13110
BSi[1]				
1	.07135	.07135	.07135	.07135
2	.01859	.00204	.00308	.00830
3	.01675	.01675	.00001	.00928
4	.02004	.02004	.02004	.02004
5	.03737	.03737	.03737	.02784
6	.03049	.01584	.02465	.02784
PSi[1]				
1	.00946	.00919	.00805	.00946
2	.01137	.01137	.00867	.01137
3	.01032	.00659	.00351	.00516
4	.00840	.00840	.00599	.00840
5	.02098	.02098	.01900	.02098
6	.01898	.00828	.01157	.01107
7	.01749	.01749	0.1749	.01749
8	.00312	.00312	.00312	.00312
9	.02100	.02100	.02100	.00334
10	.03040	.03040	.03040	.03040
11	.00575	.00276	.00496	.00485
12	.01540	.01333	.01540	.00546

[1] These coefficients are the lesser of the observed regional coefficient for the base year (DBSi and DPSi), and the observed national coefficient for the base year (CBSi and CPSi).

[2] b_2 is the sum of the BSi coefficients; b_3 is the sum of Psi coefficients.

The Population Projection Component

The modified export base model outlined heretofore can be used to estimate the total employment for the region, and thus may be used to calculate a direct estimate of population via some ratio application. This is the most frequently used technique for population projections with the export base analysis. The population projection method used for this study includes a cohort-survival model which considers changing age and sex composition patterns as well as migration estimates. The model is primarily an accounting device which records age and sex population totals over time and is designed to replicate the processes of population change over time. The model thus includes three components: births, deaths, and net migration. The population of any area open to migration may change as a result of births entering the system, deaths leaving the system, or net migration. These processes could be represented as:

$$P(t) = P(t-1) + BTHS - DTHS + NM$$

where

P(t) is the population this time period,

P(t-1) is the population the previous time period,

BTHS and DTHS are the births and deaths which have occurred in the intervening period, and

NM is the net migration (in-migration minus out-migration) between periods.

The cohort-survival model is used to calculate and record births and deaths as well as aging, while the net migration estimate is handled separately.

A cohort-survival model

Rather than a total population, the cohort-survival model is designed to monitor population change by age and sex. The analysis begins with a base year population separated into age and sex groups such that:

$$TROP = \sum_{j=1}^{2} P_{ij} \quad (i = 1, 2, 3 \ldots\ldots n)$$

where

TROP is the total population,

P_{ij} is the population of age group i, sex j (male = 1, female = 2), and

n is the number of age groups.

Although any reasonable age grouping may be used, the most common practice considers five year age intervals (for example, age group 1 is age 0-4 years, group 2 is 5-9 years, group 3 is 10-14 years, etc.).

Births are calculated as a function of the female population in childbearing age groups and the birth rate for that group:

$$BTHS = \sum_{i=1}^{m} BR_i P_{i2}$$

where

BTHS is total births,

BR_i is the birth rate for women in age group i, and

P_{i2} is the total number of women in age group i.

Note that the births are calculated only for the m child bearing age groups (usually age 10 to 49) and not the n total age groups in the population. Male births and female births are calculated as a proportion of total births.

$MBTHS = kBTHS$

$FBTHS = (1.0 - k)\ BTHS$

where

MBTHS is male births,

FBTHS is female births, and

k is a constant estimated from historical data.

Deaths may be calculated as a function of the total population of each age, sex group, and the death rate for that particular group. Deaths would be calculated as:

$MBDTHS = MBTHS \cdot MBDR$

$FBTHS = FBTHS \cdot FBDR$

$DTHS_{ij} = P_{ij} \cdot DR_{ij}$

$$TDTHS = MDBTHS + FBDTHS = \sum_{i=1}^{2} DTHS_{ij} \quad (i=1,\ 2,\ 3......n)$$

where

MBDTHS is male birth deaths,

MBDR is male birth death rate,

FBDTHS is female birth deaths,

FBDR is female birth death rate,

$DTHS_{ij}$ is deaths age group i, sex j,

DR_{ij} is death rate age i, sex j, and

TDTHS is total deaths.

The process of aging is also included in the cohort-survival model. If we survive each component of the original population (i.e., remove the deaths), we have in a sense already aged that group. However, since the size of each age group has changed through time, some further calculations are necessary to determine the size of each new component.

Since the most common procedure for deomgraphic models utilizes five year age intervals, a five-year projection period would require that each age sex group be advanced by one age group to account for the aging process. Note that the survivors of births during the intervening period now constitute the age group 0-4 years. Since the original terminal age group was not advanced, the new terminal group is now composed of survivors from last period's terminal group and also the survivors from last period's next to last age group. Annual projections, though somewhat less precise, could be approximated in a similar manner.

Estimating migration

As would be expected, the cohort-survival technique yields excellent results if there is no significant migration expected to occur into or out of the area for which the projection is being made. This no-migration assumption is clearly not applicable to most small areas. A basic limitation of the cohort-survival model for projecting population is that there is no mechanism within the model structure itself which relates the level or composition of migrants to the expected or projected economic activity. The usual practice when using this type of analysis is to extrapolate age and sex specific migration rates from a previous time into the future. For example, a net migration rate may be calculated from a previous time period and applied to a base year population to arrive at some future migration estimate.

To some extent, this approach does relate projected migration to changes in the area's economic activity; however, it implicitly assumes that changes in the level and structure of economic activity in a previous time period are similar to the economic changes expected in the projected period. Thus the problem of projecting migration is central to the problem of population projection for most areas.

Recent work by the San Diego County Comprehensive Planning Organization (1972), Hachman (1972), and Monarchi (1974) suggests a possible framework for linking new employment opportunities and migration estimation. The basic approach used in these models is to assume an exogenous migration component and an endogenous migration component which is related to projected changes in the region's total employment and to the available labor supply in the region.

The exogenous migration component may be composed of retirement migration, military related migration, or perhaps college student migration. It is likely that this component will be small for most areas and for the most part a subjective estimation will suffice. This estimated component will, of course, include not only the retirees, the military personnel, and college students but also the dependents of these migrants. (For the study area, all non-employment related migration was assumed to be retirement related and no dependents were included for this component.) The employment related migrants will also include dependents.

Assuming that for some time $(t + \theta)$ we have a projected total employment (from the employment model outlined earlier) and a projected unemployment rate for a region, the task then is to estimate the net employment related migration which can be expected for the region between time (t) and (t + θ). Using the cohort-survival model, an estimate of the total population by age and sex for (t + θ) can be made which projects the population that would occur if there were no migration (not zero net migration but zero migration). With the addition of the exogenous migration component, the total population would be given by:

$$TROP(t + \theta) = \sum_{i=1}^{n} (P_{ij}(t + \theta) + NEM_{ij})$$

where

TPOP and P_{ij} are as before, and

NEM_{ij} is the non-employment related migration.

This total population may be subdivided into a total labor force, employed workers, and unemployed workers:

$$TLAB = \Sigma(LFPR_{ij} \cdot P_{ij})$$

$$TEMP = TLAB \cdot (1.0\text{-}UR)$$

$$TUEMP = TLAB - TEMP$$

where

TLAB is the labor force,

$LFPR_{ij}$ is the labor force participation rate for the group ij,

TEMP is total calculated employment,

UR is the projected unemployment rate, and

TUEMP is total calculated employment.

In the highly unlikely event that the total calculated employment (TEMP) from this procedure is exactly equal to the projected total employment, the net employment related migration for this period would be exactly zero. In this case the projected total population would be:

$$\mathrm{TPOP}\ (t + \theta) = \sum_{i=1}^{n} (P_{ij}\ (t + \theta) + \mathrm{NEM}_{ij} + \mathrm{EM}_{ij})$$

where

P_{ij} $(t + \theta)$ is the projected population from the cohort-survival model.

NEM_{ij} is the exogenous non-employment migration, and

EM_{ij} is the employment-related migration (zero).

This projected population would be completely consistent with the projected total employment and the projected unemployment for the area.

What is far more likely, of course, is that the calculated employment (TEMP) is not equal to the projected employment and consequently some employment migration must occur in order to balance the available supply of labor and the projected demand. If the two are different, and if the calculated employment is greater than the total projected employment, then we must conclude that some net employment related out-migration must have occurred between time (t) and (t + θ). On the other hand, if the projected employment is greater than the calculated employment, then we must conclude that net employment related in-migration must have taken place.

If we can assume or estimate a distribution, a labor force participation rate, and an unemployment rate for the employment related migrants, then an estimate of the age and sex totals of migrants and for the projected total population can be prepared. The estimation procedure would be:

$$\text{TEM} = (\text{TPEMP} - \text{TEMP}) \cdot \{(1.0 + \text{UR}) \cdot \sum_{i=1}^{n} (\text{DM}_{ij} \cdot \text{LFPR}_{ij})\}$$

$$\text{EM}_{ij} = \text{DM}_{ij} \cdot \text{TEM}$$

$$P_{ij}(t + \theta) = P_{ij}(t + \theta)\ \text{NEM}_{ij} + \text{EM}_{ij}$$

$$\text{TROP}(t + \theta) = \sum_{i=1}^{n} P_{ij}(t + \theta)$$

$$\text{TLAB} = \sum_{i=1}^{n} \text{LFPR}_{ij} \cdot P_{ij}(t + \theta)$$

$$\text{TEMP} = \text{TLAB} \cdot (1.0 - \text{UR})$$

$$\text{TUEMP} = \text{TLAB} - \text{TEMP}$$

where

ΣDM_{ij} (migrant distribution) equals 1.0,

TEM is total employment related migrants, and

TPEMP is total projected employment.

The estimated total population for time $(t + \theta)$ is consistent with the projected total employment and the projected unemployment. If we assume that in- and out-migrants move on the very last day of the time period, then the total population estimate is completely consistent with the projected employment and unemployment. If we apply this condition, then the projected labor supply is now exactly equal to the projected labor demand for the area. Utilizing this procedure, we can now approximate the changes that occur in a regional population system as a result of natural increases and decreases, and the migration which occurs as a result of the interaction between the natural population forces and changes in the levels of economic activity in the region.

Allocation of Project Employment to Place of Residence

The primary data inputs for the population-employment model are the projected levels of employment for the basic industries and the export-oriented employment for business-serving and population-serving industries. In addition to a trend element which is included for each of these industries, the projected employment for the basic industries also includes employee requirements for approximately twenty-five water and energy-related developments in the immediate study area. These future employee requirements were estimated on an annual basis for the period 1975-1990 and are based largely upon personal interviews and recent published literature.

In order to examine some of the possible impacts associated with the additional employment anticipated for these individual projects, a straightforward gravity type model was devised as a means of allocation project or direct employment among the existing communities in the study area. Since most of the actual projects are located in remote areas of the region, the allocation of direct employment to place of residence is a necessity. Given the community allocations, county level totals were calculated and these direct employee estimates were used as data inputs for the population-employment model. Depending upon the estimated propensity to import (as specified by the employment coefficients), the county will experience multiplier effects from these resident employees even though the place of employment may be outside that county. The general form and description of the gravity model is outlined hereafter.

The gravity model

After each project site was located, the distance in miles to each plausible community of residence was calculated. While it is recognized that many persons may choose to locate outside established communities, these cities and towns will undoubtedly continue to serve as "activity centers" for the region. The allocation to communities does not imply that all of the employees will reside inside the cities and towns. Since many of the developments occur in areas of limited access, all distance estimates were made for both primary and secondary type road surfaces.

All mileage estimates were then converted to a time basis using a travel time of 40 mph for secondary surfaces and 55 mph for primary routes. In cases where several alternative routes to a community were possible, only the one with the lowest travel time was considered with the others ignored. A maximum one-way travel time of one hour was used to further delimit the possible community area.

The actual employment allocations were then made based upon a computed attraction index with the attraction inversely related to the time factor (distance) and directly related to the community population. The attraction index is calculated as:

$$A_i = \frac{P_1}{T_{i1}} + \frac{P_2}{T_{i2}} + \frac{P_3}{T_{i3}} + \frac{P_n}{T_{in}} = \sum_{j=1}^{n} \frac{P_j}{T_{ij}}$$

where

A_i is the attraction index for project i,

P_1, P_2, P_3, P_n is the population for communities 1, 2, 3, n, and

T_{i1}, T_{i2}, T_{i3}, T_{in} is the travel time for project i to each community.

The allocation to each community is proportional to each community so that:

$$AE_{i1} = \left(\frac{P_1}{T_{i1}} \Bigg/ \sum_{j=1}^{n} \frac{P_j}{T_{ij}}\right) \cdot TE_i$$

where

AE_{i1} is the allocated employment from project i to community 1, and

TE_i is the total annual employment for project i.

The attraction index was updated periodically with new population estimates for the communities. The base year was 1974 with that index used for 1975-76; 1976 was used for 1977-78; 1978 was used for 1979-80; 1980 was used for 1981-83; 1983 was used for 1984-85; and the 1985 index was used for 1986-1990. Because of the great variations in some project employment, some adjustments to the allocation were necessary. For example, because of the magnitude of some projects, employees allocated to a community in one time period from a single project might be allocated to a different community in a succeeding period. This was deemed inappropriate and individual adjustments were made in the allocations to insure that no reductions in allocated employment from a single project would occur unless the total project employment was declining. For most instances then, once a particular project employee is allocated to a community, he remains in that community for the life of the project or until that project employment is reduced or eliminated.

TABLE XI-3

One-way Travel Time Matrix (minutes)

	Communities							
Projects	Hayden	Oak Creek	Steam-boat Springs	Yampa	Craig	Dinosaur	Meeker	Rangely
Yampa Project	26		53		7		50	
Hayden Expansion	5	47	23	57	24			
Yellow Jacket							34	
Savory Pot-Hook	60				41			
Cross Mtn.-Juniper	51				32		60	
Superior						60	23	44
Ca-							36	55
Cb-							48	
Ua-Ub						43		62
Craig Mine	26		53		7		50	
Energy Fuels	29	15	30	25	58			
Colowyo	49				31		21	
Grace R. R.	49				31		21	
Seneca 2-W	17	53	44	63	36			
Ruby Construction	27	42	54	52	46			
Thomas Woodward	17	32	15	42	36			
Merchants Petroleum								
Midland Coal								
Paul Coupey								
Consolidation Coal	61				43		11	
AEP	20		47		26			
Coal Fuels	6	57	33		22			
Moonlake						24	58	16
Empire Energy	30		57		11		47	
UI: Danforth								
Craig 3, 4	26		53		7		50	

TABLE XI-2

Direct Employment Matrix

(Construction / Permanent)

	1975	1976	1977	1978	1979	1980	1981	1982
Base Scenario:								
Yampa Project	335 /	1,357 /	1,158 / 36	559 / 72	/ 110	/ 110	/ 110	/ 110
Hayden Expansion	350 / 25	/ 35	/ 35	/ 35	/ 35	/ 35	/ 35	/ 35
Yellow Jacket					370 /	370 /	370 /	370 /
Savory Pot-Hook	250 /	250 /	250 /	250 /	250 /	/ 10	/ 10	/ 10
Cross Mtn.-Juniper						380 /	380 /	380 /
Craig Mine	/ 39	20 / 50	51 / 100	0 / 151	/ 165	/ 165	/ 165	/ 165
Oil Shale	35 /	460 /	700 /	1,165 /	700 / 150	710 / 750	2,390 / 900	3,850 / 1,100
Site Specific Scenarios:								
Energy Fuels		90 / 18	/ 39	/ 85	/ 110	/ 137	/ 166	/ 198
Colowyo		100 / 124	100 / 174	/ 210	/ 244	/ 244	/ 244	/ 244
Grace R. R.		100 /	100 /	110 / 14	/ 29	/ 29	/ 29	/ 29
Seneca 2-W		61 /	/ 44	/ 44	/ 44	/ 44	/ 44	/ 44
Ruby Construction		/ 65	/ 65	/ 65	/ 65	/ 65	/ 65	/ 65
Regional Scenario:								
AEP			/ 75	/ 110	/ 150	/ 210	/ 275	/ 275
Coal Fuels			/ 290	/ 290	/ 290	/ 290	/ 290	/ 290
Moonlake Electric			200 /	400 /	800 /	1,400 /	1,800 / 376	1,600 / 412
Empire Energy			/ 78	/ 78	/ 78	/ 78	/ 78	/ 78
Craig 3, 4					950 /	811 / 23	391 / 46	/ 70
Other Coal Mines						/ 575	/ 575	/ 575

Note: These data are over and above any employment levels as of 7/75.

TABLE XI-2 (Cont.)

Direct Employment Matrix

(Construction / Permanent)

	1983	1984	1985	1986	1987	1988	1989	1990
Base Scenario:								
Yampa Project	/ 110	/ 110	/ 110	/ 110	/ 110	/ 110	/ 110	/ 110
Hayden Expansion	/ 35	/ 35	/ 35	/ 35	/ 35	/ 35	/ 35	/ 35
Yellow Jacket	370 /	/ 10	/ 10	/ 10	/ 10	/ 10	/ 10	/ 10
Savory Pot-Hook	/ 10	/ 10	/ 10	/ 10	/ 10	/ 10	/ 10	/ 10
Cross Mtn.-Juniper	380 /	380 /	/ 10	/ 10	/ 10	/ 10	/ 10	/ 10
Craig Mine	/ 165	/ 165	/ 165	/ 165	/ 165	/ 165	/ 165	/ 165
Oil Shale	3,850 / 1,110	3,000 / 2,305	1,000 / 3,380	600 / 3,668	/ 4,090	/ 4,113	/ 4,135	/ 4,135
Site Specific Scenarios:								
Energy Fuels	/ 233	/ 268	/ 306	/ 326	/ 346	/ 369	/ 393	/ 418
Colowyo	/ 244	/ 244	/ 244	/ 244	/ 244	/ 244	/ 244	/ 244
Grace R. R.	/ 29	/ 29	/ 29	/ 29	/ 29	/ 29	/ 29	/ 29
Seneca 2-W	/ 44	/ 44	/ 44	/ 44	/ 44	/ 44	/ 44	/ 44
Ruby Construction	/ 65	/ 65	/ 65	/ 65	/ 65	/ 65	/ 65	/ 65
Regional Scenario:								
AEP	/ 275	/ 275	/ 275	/ 275	/ 275	/ 275	/ 275	/ 275
Coal Fuels	/ 290	/ 290	/ 290	/ 290	/ 290	/ 290	/ 290	/ 290
Moonlake Electric	1,400 / 445	800 / 445	400 / 485	600 / 532	600 / 564	/ 571	/ 672	/ 746
Empire Energy	/ 78	/ 78	/ 78	/ 78	/ 78	/ 78	/ 78	/ 78
Craig 3, 4	/ 70	/ 70	/ 70	/ 70	/ 70	/ 70	/ 70	/ 70
Other Coal Mines	/ 575	/ 575	/ 575	/ 575	/ 575	/ 575	/ 575	/ 575

Note: These data are over and above any employment levels as of 7/75.

TABLE XI-5

Moffat County Population Projection

	Craig			Dinosaur			County Total		
Year	Base	Δ Cum.	Cumulative	Base	Δ Cum.	Cumulative	Base	Δ Cum.	Cumulative
1975	8006	0	8006	300	0	300	9001	0	9001
1976	10853	1143	11996	307	0	307	11872	1143	13015
1977	10539	2084	12623	351	36	387	11621	2120	13741
1978	8918	2090	11008	394	72	466	10064	2161	12225
1979	7859	5098	12927	392	149	541	9026	5217	14243
1980	8945	4776	13721	408	252	660	10154	5028	15182
1981	9133	4366	13499	431	368	799	10392	4734	15126
1982	9429	3331	12760	581	342	923	10870	3673	14543
1983	9721	3499	13220	807	322	1129	11421	3821	15242
1984	10025	3595	13620	1133	233	1366	12087	3828	15915
1985	9320	3716	13036	947	174	1121	11234	3890	15124
1986	9744	3782	13526	921	193	1114	11674	3975	15649
1987	10119	3836	13955	915	217	1132	12086	4053	16139
1988	10516	3897	14413	935	89	1024	12549	3986	16535
1989	10932	3956	14888	955	111	1066	13035	4068	17103
1990	11373	4002	15375	975	126	1101	13547	4128	17675

Notes:

"Base" is the base scenario population projection; it is a forecast of population without coal-related development.

"Δ Cum." is the incremental population growth over and above the Base that is associated with coal-related development.

"Cumulative" is the sum of the Base and Δ Cum. and is the forecast of total population with coal-related development.

TABLE XI-6

Rio Blanco County Population Projection

Year	Meeker Base	Meeker Δ Cum.	Meeker Cumulative	Rangely Base	Rangely Δ Cum.	Rangely Cumulative	County Total Base	County Total Δ Cum.	County Total Cumulative
1975	1809	0	1809	1705	0	1705	5431	0	5431
1976	2613	356	2969	1736	0	1736	6300	356	6656
1977	3389	550	3939	1919	316	2235	7300	867	8167
1978	4488	634	5122	2103	622	2725	8629	1255	9884
1979	5280	1157	6437	2130	1254	3384	9499	2410	11909
1980	5672	1607	7279	3356	2195	5551	11171	3803	14974
1981	7416	3180	10596	6398	3767	10165	16021	6947	22968
1982	8874	2988	11862	9125	3416	12541	20275	6405	26680
1983	8274	2911	11185	8878	3121	11999	19501	6032	25533
1984	6604	2633	9237	9033	1830	10863	18065	4462	22527
1985	6629	2468	9097	7838	924	8762	16978	3392	20370
1986	7209	2647	9856	7664	1466	9130	17470	4114	21584
1987	6924	2677	9601	7614	1541	9155	17230	4218	21448
1988	7077	2155	9232	7793	841	8634	17661	2996	20657
1989	7223	2293	9516	7959	1007	8966	18077	3300	21377
1990	7353	2372	9725	8094	1112	9206	18451	3484	21935

Notes:

"Base" is the base scenario population projection; it is a forecast of population without coal-related development.

"Δ Cum." is the incremental population growth over and above the Base that is associated with coal-related development.

"Cumulative" is the sum of the Base and Δ Cum. and is the forecast of total population with coal-related development.

TABLE XI-7

Routt County Population Projection

Year	Hayden Base	Hayden Δ Cum.	Hayden Cumulative	Oak Creek Base	Oak Creek Δ Cum.	Oak Creek Cumulative	Steamboat Springs Base	Steamboat Springs Δ Cum.	Steamboat Springs Cumulative
1975	1839	0	1839	1286	0	1286	5853	0	5853
1976	1709	212	1921	1372	116	1488	6378	286	6664
1977	1861	509	2370	1498	97	1595	6902	556	7458
1978	1958	521	2479	1623	120	1743	7316	492	7808
1979	1966	678	2645	1745	137	1882	7545	761	8306
1980	2212	727	2939	1868	172	2040	8089	924	9013
1981	2296	788	3084	1940	190	2130	8396	918	9314
1982	2383	752	3135	2011	210	2221	8704	855	9559
1983	2468	776	3244	2082	227	2309	9010	898	9908
1984	2551	796	3347	2153	248	2401	9316	937	10253
1985	2517	826	3343	2224	272	2496	9627	971	10598
1986	2524	837	3361	2237	286	2523	9683	995	10678
1987	2527	850	3377	2250	299	2549	9737	1020	10757
1988	2529	867	3396	2262	315	2577	9787	1049	10836
1989	2531	882	3413	2274	331	2605	9832	1076	10908
1990	2533	896	3429	2287	348	2635	9885	1107	10992

Notes:

"Base" is the base scenario population projection; it is a forecast of population without coal-related development.

"Δ Cum." is the incremental population growth over and above the Base that is associated with coal-related development.

"Cumulative" is the sum of the Base and Δ Cum. and is the forecast of total population with coal-related development.

TABLE XI-7 (Cont.)

Routt County Population Projection

	Yampa			County Total		
Year	Base	Δ Cum.	Cumulative	Base	Δ Cum.	Cumulative
1975	357	0	357	11434	0	11434
1976	354	43	397	11939	655	12594
1977	366	33	399	12785	1195	13980
1978	379	39	418	13465	1174	14639
1979	393	43	436	13877	1620	15497
1980	408	51	459	14842	1874	16716
1981	425	55	480	15362	1951	17313
1982	442	63	505	15891	1880	17771
1983	460	71	531	16416	1972	18388
1984	479	79	558	16941	2059	19000
1985	498	87	585	17355	2155	19510
1986	517	91	608	17500	2209	19709
1987	537	96	633	17639	2265	19904
1988	558	100	658	17777	2330	20107
1989	579	104	683	17915	2393	20308
1990	600	108	708	18054	2458	20512

Notes:

"Base" is the base scenario population projection; it is a forecast of population without coal-related development.

"Δ Cum." is the incremental population growth over and above the Base that is associated with coal-related development.

"Cumulative" is the sum of the Base and Δ Cum. and is the forecast of total population with coal-related development.

CRAIG OPINION SURVEY
QUESTIONNAIRE

and

MEEKER OPINION SURVEY
QUESTIONNAIRE

CRAIG DEVELOPMENT STUDY

FIRST, we would like to ask some questions about the whole issue of growth, especially as it might occur in the Craig area.

1. The population of Craig is currently around 6000 people. What is the largest number of people you would want to see living here ten years from now? ______
____

2. Moffat County presently has about 9000 people. What is the largest number of people you would want to see living in the county ten years from now? ______
____

3. Would you want to see growth occur around here if it were only for a short time, followed by a drop again? ___Yes ___Unsure ___No

4. Do you feel the pace of growth in Craig has been...
___Too slow ___ About right ___Too fast

5. What do you see as the costs of growth for Craig? ______________
____
____

6. What do you see as the benefits of growth for Craig? ______________
____
____

7. To your way of thinking, are the costs you outlined...
___More than the benefits
___About equal to the benefits
___Less than the benefits
___No opinion/unsure

8. Of the groups I read off, which should be the main one to pay for growth?
___New industry ___Incoming population ___Merchants
___Existing population ___Developers ___Other (________)

9. Which should be the last one to pay for growth?
___New industry ___Incoming population ___Merchants
___Existing population ___Developers ___Other (________)

10. Can you identify any group within the population that would be most hurt by growth? ______________________________
In what way? ______________________________
____

11. Can you identify any group within the population that would be most benefited by growth? ______________________________
In what way? ______________________________
____

12. Has planning for growth in Craig been...
a. ___Handled very well ___Handled okay ___Handled poorly
b. ___Too little ___About right ___Too much
c. ___Even-handed ___Favorable to a few

SOURCE: SOCIAL CHANGES SYSTEMS

13. Should Craig engage in any further annexation? ___Yes ___Unsure ___No

If YES, under what conditions or for what reasons? ________________

____

If NO, why not? ________________________________

____

14. Can you tell where Craig begins and ends now? ___Yes ___Unsure ___No

15. How important is that to you?
___Very imp. ___Imp. ___Unsure ___Unimp. ___Very unimp.

16. Do you think that increased mining or a power plant operation will have...
___A positive effect on the natural environment
___No effect on the natural environment
___A negative effect on the natural environment

In what way? ________________________________

17. What situation /event/person currently presents the biggest threat to the natural environment around here? ________________

____

18. What aspects of the physical appearance of Craig would be...

Helped as a result of growth ________________________

Worsened as a result of growth ________________________

NEXT, we have some questions about where exactly growth might take place in the Craig area.

1. If growth is to occur in this region as part of increased mining activity or power plant construction, where should that growth occur?
___In and around existing communities primarily
___In a new town primarily
___In a new town as well as in and around existing communities

2. Would you want to see growth occur in or around any of these following towns?

	Yes	Unsure	No		Yes	Unsure	No
Craig	1	2	3	Rangely	1	2	3
Steamboat Springs	1	2	3	Hayden	1	2	3
Rifle	1	2	3	Axial	1	2	3
Meeker	1	2	3	Maybell	1	2	3

3. If there is to be a new townfor a mine or power plant, should it be located...
___Near Craig
___Near the mine or power plant

4. If a new town were to develop near Craig, how close would you want it to be to Craig?
___Closer than 5 miles
___6-25 miles away
___26-50 miles away
___More than 50 miles away

5. Of the possible growth sites on this map, which one do you feel would be best for a new town of several thousand people, and why? Which one would be worst for a new town, and why?

Best: _____ ________________________________

____

Worst: ____ ______________________________

____

GROWTH can change the life of a community in many cases. Let's talk about what you see possibly happening in Craig.

1. Many communities have some basic lines along which the population is divided; maybe it's the whites vs. the non-whites, or the people on the hill vs. the people in the valley, etc. What are the most important lines along which the population of Craig is divided? ______________________________

____

2. Sometimes when a community grows in population, it becomes harder to know a lot of people.

	Yes	Unsure	No
Have you experienced this in Craig already?	1	2	3
Do you think this would happen if the population grew from 6000 to 20,000 + in ten years?	1	2	3
From 6000 to 15,000 in ten years?	1	2	3
From 6000 to 10,000 in ten years?	1	2	3

3. What kind of sense of community do you feel Craig now has?
   - ___Strong sense of community
   - ___Adequate/so-so
   - ___Weak sense of community
   - ___No opinion/unsure

4. Generally when a community gets larger, the variety of people becomes wider. How would you regard this if it were to happen in Craig?
   - ___Good for the town
   - ___Good & bad for town
   - ___Bad for the town
   - ___No opinion/unsure

5. Can you think of any social conflicts here that would be heightened/made worse by growth? ______________________________

____

6. Can you think of any social conflicts here that would be lessened/decreased by growth? ______________________________

____

7. Do you see any problem for newcomers in adjusting to Craig?

   ___Yes ___Unsure ___No

8. Do newcomers seem to be welcomed by the community?

   ___Yes ___Unsure ___No

9. If the town's population were to grow, could you imagine a situation where...

	Yes	Unsure	No
There are too many people to fill the available community leadership positions	1	2	3
There are too many new positions of community leadership created & not enough people to fill them	1	2	3

GROWTH can also have effects on things like the economy, government, schools, and so forth. We have a few questions about your views on those situations.

1. Do you see that growth would have any impact on the business community here?
___**Good** ___**Mixed** ___**Bad** ___**No opinion/unsure**
Explain ____
____

2. Do you think growth would have any economic or financial impact upon you personally? ___**Good** ___**Mixed** ___**Bad** ___**No opinion/unsure**
Explain ____
____

3. Would the school system be benefited or hurt by population growth in Craig?
___**Benefited** ___**Mixed consequences** ___**Hurt** ___**Unsure/no opin.**
In what ways? ____

4. Would increased population in Craig make local government more or less responsive, or have no impact on their responsiveness to the people?

	More	**No diff**	**Less**
Craig town council	1	2	3
County commissioners	1	2	3

5. What community facilities or services do you think would be most overburdened by growth?
____

6. Which ones do you think would most likely get developed/improved in the wake of growth?
____

NOW we need to know a few facts about you and your family to understand better your answers to the other questions.

1. **What is your age?** _____ Sex: F M Jt Ot Eth: An Bl Ch Or Ot

2. **What is your marital status?**
Married Single Separated Divorced Widowed Living Together

3 **What is your spouse's age?** ______

4. **Do you have any children living at home? or any other persons?**
Ages: ___ ___ ___ ___ ___ ___ ___ ___ Others: _____

5. **How many years have you lived...**
in Craig_____ in Moffat County_____ in Colorado_____

6. **Do you have any plans to move soon?** Yes Unsure No
If YES, why? ____

7. **If you could not live in Craig, what would be your second choice of a place to live?** ______________________________

8. **Do you own or rent this house?** Own Rent
Type of dwelling: ___Single family ___Mobile home ___Apartment ___Motel ___Other (______________)

9. **What is the highest level of formal education you completed?**
___Under 7 years of school
___7 to 9 years of school
___10 to 11 years of school (part of high school)
___High school graduate
___1 to 4 years of college/business school (or AA degree but not bachelor's degree)
___4 year college graduate (bachelor's degree)
___Received professional degree (MA, MS, PhD, law degree, MD, etc.)

10. **What is your present occupation?** ______________________________

11. **Your spouse's?** ____

12. **Where did you meet most of your friends, or people with whome you socialize most frequently, in Craig? (multiple answers if applicable)**
___At work
___At church
___At clubs/community activities
___At recreational activities
___At local bars
___At neighbors
___Other (______________________)

13. **In which of the following categories would your annual family income be?**
___Under $4000
___$4000 - $6999
___$7000 - $9999
___$10,000 - $14,999
___$15,000 - $24,999
___$25,000 and over

14. **Are there any other comments you would like to make?**

CHARACTERISTICS OF THE SAMPLE
(Percentages)

Age

	Respondent	Spouse		Respondent	Spouse
Under 19	2.4	2.8	Under 30	33.0	32.4
20 - 29	30.6	29.6			
30 - 39	24.7	26.8	30 - 49	36.5	46.5
40 - 49	11.8	19.7			
50 - 59	11.8	11.3	50 and over	30.4	21.1
60 - 64	8.2	2.8			
65 and over	10.4	7.0			

Sex

Female	66.7
Male	24.1
Joint	9.2

Ethnicity

Anglo	90.8
Chicano	5.7
No Response	3.4

TOTAL RESPONSES: 87

Marital Status

Married	80.5
Single	6.9
Separated	3.4
Divorced	1.1
Widowed	6.9
No Response	1.1

Children at home

None	37.9
1	17.2
2	27.6
3	12.6
4	2.3
5	2.3

Family Life Cycle Stage

Pre-child	9.2	35.6
Child-bearing	26.4	
Child-rearing	25.3	32.2
Child-launching	6.9	
Post-child	2.3	32.1
Older, childless	21.8	
Widow/widower	8.0	

Years in Craig/Moffat County/Colorado

	Craig	County	State
Less than 1 year	22.1	20.0	7.1
1.0 - 2.9 years	9.3	9.4	9.4
3.0 - 4.9 years	3.5	3.5	3.5
5.0 - 6.9 years	5.8	5.9	1.2
7.0 - 8.9 years	3.5	3.5	1.2
9.0 - 10.9 years	4.7	3.5	2.4
11.0 - 19.9 years	15.1	11.8	14.1
20.0 or more years	36.0	42.4	61.2

Plans to move	
Yes	5.7
Unsure	10.3
No	83.9

Reason for moving	
Retiring	2.2
Weather	1.1
Other	1.1
No Response	1.1
Not App.	94.3

Second choice home		
Western Colorado	33.3	48.0
Front Range Colorado	10.7	
Elsewhere Colorado	4.0	
Montana	9.3	
Other Western state	21.3	
Elsewhere USA	9.3	
Warmer climate	4.0	
Small community	2.7	
Other	5.3	

Own/Rent	
Own	69.8
Rent	30.2

Type dwelling	
Single family	73.6
Mobile home	14.9
Apartment	11.5

Formal education		
Less than 7 years	2.3	58.0
7 - 9 years	8.1	
10 - 11 years	13.9	
High school graduate	33.7	
Some college	32.6	42.0
College graduate	3.5	
Professional degree	5.8	

Occupation

	Respondent	Spouse
Professional	10.3	8.0
Managerial	11.5	9.2
Sales	3.4	8.0
Clerical	4.6	2.3
Craftspeople	3.4	6.9
Operatives	-	1.1
Transportation operative	1.1	9.2
Laborers	6.9	11.5
Farm laborers	1.1	-
Service workers	5.7	10.3
Retired	9.2	3.4
Unemployed	2.3	-
Housespouse	37.9	10.3
No Response/Not Applicable	2.3	19.5

Socializing places (multiple responses allowed)

At work	54.0
At church	41.4
At clubs, etc.	36.8
At recreation	31.0
At local bars	4.6
At neighbors	49.4
Other	22.4

Family income

Under $4000	5.7	37.7
$4000 - 6999	8.0	
$7000 - 9999	24.1	
$10,000 - 14,999	31.0	
$15,000 - 24,999	14.9	19.5
$25,00 and over	4.6	
No Response	11.5	

AREA OPINION SURVEY
MEEKER, COLORADO

CONCERNS WITH JOBS FOR YOUTH

. . . . How Would You Rate:	Exc.	Good	Fair	Poor*
1. Local job opportunities for youth after graduation.				
2. Job opportunities for school age youth.				

- Please comment on back concerning "Poor" ratings.

CONCERNS WITH RECREATION

. . . . How Would You Rate:	Exc.	Good	Fair	Poor*
1. Recreational opportunities				
a. Children				
b. Youth				
c. Adults				
d. Senior citizens				

- Please comment on back concerning "Poor" ratings.

. . . . What About These Issues:	Yes	No
2. Should the old football field located between Sixth and Seventh Street and Hill and Cedar street be maintained as a public recreation area?		
3. Do you think the present Junior High would make a suitable city hall and recreation area if abandoned by the school district?		
4. Should Meeker provide an ice skating rink?		
5. Should Meeker provide expanded tennis courts?		

CONCERNS WITH PLANNING

. . . . How Would You Rate:	Exc.	Good	Fair	Poor*
1. Availability of adequate housing:				
a. Trailer space				
b. Apartments				
c. Houses for sale				
d. Houses for rent				
e. Vacant lots for building sites				

Please comment on back concerning "Poor" ratings.

SOURCE: MOFFAT COUNTY
PLANNING COMMISSION

CONCERNS WITH EDUCATION

. . . . How Would You Rate:	Exc.	Good	Fair	Poor*
1. Quality of educational programs				
a. Elementary school				
b. Junior high				
c. High school				
2. Availability of school facilities to the community.				
3. Responsiveness of public school personnel to peoples needs				
4. Responsiveness of school board to peoples needs.				

- Please comment on back concerning "Poor" ratings.

. . . . What About These Issues:	Yes	No
5. Do you feel the present junior high building should be replaced in the near future?		
6. If so, should the new junior high school be in a separate location from the high school?		
7. Do you think the Meeker school district citizens would pass a bond issue for a new junior high school in the near future?		
8. Would you vote in favor of a bond issue for a new junior high school in the near future?		
9. Do you think Meeker school district citizens would pass a bond issue for construction of school buildings for increased population caused by oil shale impact?		
10. Would you vote in favor of a bond issue for construction of school buildings for increased population caused by oil shale impact?		
11. Do you feel the high school library should be open to the public?		
12. Do you feel there are enough local informal educational opportunities available?		
13. Would you favor extending the Colorado Northwestern Community College (Rangely) School District to include Eastern Rio Blanco County?		

14. The maximum size of individual schools should be restricted to: (Circle one answer for each)

a. Elementary schools	300	400	500	Other____(Specify)
b. Jr. High or Middle School	300	400	500	Other____(Specify)
c. High schools	300	400	500	Other____(Specify)

. . . . What About These Issues: **Yes** **No**

2. Do you feel that dilapidated and abandoned buildings in the town should be removed? ____ ____
3. Do you feel residential development should be limited to unproductive agriculture areas? ____ ____
4. Should the Town of Meeker's boundaries be expanded? ____ ____
5. If the results of a planning effort show that land use control is required, would you favor strong local authority? ____ ____

Scale—Strongly Agree, Agree, Disagree, Strongly Disagree.

	Strongly Agree	Agree	Disagree	Strongly Disagree
6. The majority of growth caused by the resource development should occur in Meeker.	____	____	____	____
7. It is desirable that "new towns" be established to handle the resource development.	____	____	____	____
8. We should let communities in Garfield County take the majority of the growth associated with the shale oil development.	____	____	____	____
9. Developers should assume the total cost of new city services for their development.	____	____	____	____
10. To provide adequate quality and quantity of water for domestic and fire protection, it is desirable to improve the facility through a bonding issue.	____	____	____	____

Check your answer on each of the following:

11. With proper planning what percentage of the total housing would you find acceptable as mobile homes within the Meeker community? 20% 30% 40% 50% 60% 70%
12. How would you like to see the Meeker area grow? (Check one only)
    a. ☐ As industrial and mining
    b. ☐ As a recreation area
    c. ☐ As a retirement area
    d. ☐ As a combination of the above
    e. ☐ Not at all
13. From the current population level of approximately 1700, to what amount would you like to see Meeker grow? (Check one only)
    a. ☐ No growth
    b. ☐ 3000 — 5000
    c. ☐ 6000 — 10000
    d. ☐ 10000 — 15000
    e. ☐ Over 15000

CONCERNS WITH PUBLIC UTILITIES

. . . . How Would You Rate:	Exc.	Good	Fair	Poor*
1. Quality of water in Meeker	____	____	____	____
2. Surface water drainage	____	____	____	____

* Please comment on back concerning "Poor" ratings.

. . . . What About These Issues: **Yes** **No**

3. Are you aware that Meeker has a water pressure problem? ____ ____
4. Are you aware that adequate fire protection depends on water pressure zones in the city of Meeker? ____ ____
5. Are you aware of possible summer water rationing in Meeker? ____ ____
6. Should the residents of Meeker participate in a county-wide domestic water system? ____ ____
7. Should town services like sewer and water be extended beyond town limits? ____ ____
8. Are you willing to help share the cost of providing services for new growth? ____ ____

CONCERNS WITH BUSINESS ACTIVITIES

. . . . How Would You Rate:	Exc.	Good	Fair	Poor*
1. The attitude of local retailers toward customer service.	____	____	____	____

* Please comment on back concerning "Poor" ratings.

. . . . What About These Issues? **Yes** **No**

2. Do you feel that the Meeker area should encourage new retail business enterprises? ____ ____
3. If you have a complaint about a consumer product or service do you know where to go for help? ____ ____

CONCERNS WITH HEALTH CARE

Yes **No**

1. Should Pioneers Hospital play a more active role in the community in providing for home health nursing? ____ ____
2. Alcoholism, by statute, is now considered a disease rather than a crime. Should the hospital use its facilities for the treatment of the alcoholic in cases where a crime is not involved? ____ ____
3. Should the nursing home be enlarged to provide more nursing home beds? ____ ____

CONCERNS WITH GOVERNMENT

. . . . How Would You Rate:	Exc.	Good	Fair	Poor*
1. Government response to community needs:				
a. Town officials	____	____	____	____
b. Town planning and zoning	____	____	____	____
c. County officials	____	____	____	____
d. County planning and zoning	____	____	____	____
e. State officials	____	____	____	____
2. Street or highway maintenance?				
a. Town	____	____	____	____
b. County	____	____	____	____
c. State	____	____	____	____
3. Fire protection and equipment	____	____	____	____
4. Law enforcement and police protection				
a. City police	____	____	____	____
b. Sheriff	____	____	____	____

* Please comment on back concerning "Poor" ratings.

. . . . How About These:	Yes	No
5. Do you feel the community is run by and for a particular group of citizens? (If Yes, please specify the group on the comment page)	____	____
6. Do you feel that the existing dog control ordinance should be strictly enforced?	____	____

7. What are the two most important problems facing the Town of Meeker? (Please respond on the comment page.)

GENERAL INFORMATION

1. Sex
   - a. ☐ Male
   - b. ☐ Female
2. What is your principal occupation at the present time?
   - a. ☐ Retired
   - b. ☐ Student
   - c. ☐ Housewife
   - d. ☐ Farming or Ranching
   - e. ☐ Educator
   - f. ☐ Government
   - g. ☐ Business
   - h. ☐ Other____________________(Please specify)
3. Circle last grade completed in school:

   Myself: less than 6, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

   Spouse: less than 6, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17
4. Where do you live?
   - a. ☐ In town
   - b. ☐ Outside city limits
5. I presently:
   - a. ☐ Own a home
   - b. ☐ Lease
   - c. ☐ Rent a house
   - d. ☐ Rent an apartment
   - e. ☐ Other____________________(Please specify)
6. Amount of land you own within the city limits of Meeker.
   - a. ☐ None
   - b. ☐ 1 Lot
   - c. ☐ 2-10 Lots
   - d. ☐ 1 or more acres
7. Number of housing units you own in Meeker.
   - a. ☐ None
   - b. ☐ 1 unit
   - c. ☐ 2-5 units
   - d. ☐ 5 or more units
8. Approximate annual income of your family last year.
   - a. ☐ Under $1000.00
   - b. ☐ $1001.00 — $4999.00
   - c. ☐ $5000.00 — $7999.00
   - d. ☐ $8000.00 — $12999.00
   - e. ☐ $13000.00 and over
9. Total of years you have lived in Meeker.
   - a. ☐ Under 1 year
   - b. ☐ 1— 5 years
   - c. ☐ 6—10 years
   - d. ☐ 11—20 years
   - e. ☐ over 20 years
10. If housing were available to suit your needs and budget, would you: (Check one)
    - a. ☐ Buy a new home
    - b. ☐ Buy an older home
    - c. ☐ Buy a new mobile home and put it on a lot of your own
    - d. ☐ Buy a new mobile home and put it on a modern mobile home park containing adequate open space and controls with enforcement
    - e. ☐ Move a mobile home from an existing location to a modern mobile home park containing adequate open space and controls with enforcement

	Yes	No
11. Are you registered to vote?	____	____

COMMENT PAGE—If you came to the Meeker area within the last ten years, what three things most attracted you? (Please comment on reverse side.)

CHARACTERISTICS OF THE SAMPLE
(Percentage)

Sex

Male	56
Female	44

Occupation

Retired	23
Student	2
Housewife	17
Farming or Ranching	12
Educator	6
Government	8
Business	21
Other	10

Last Grade Completed in School

	Self	Spouse
Less than 6	a	a
6	a	0
7	a	0
8	5	6
9	3	2
10	3	5
11	5	3
12	32	38
13	10	11
14	10	10
15	5	3
16	12	13
17	13	8

[a] less than one percent

Location of Residence

In town	74
Outside City Limits	26

Own/Rent

Own a home	75
Lease	1
Rent a house	12
Rent an apartment	3
Other	9

Land Ownership within City Limits

None	37
1 lot	19
2-10 lots	41
1 or more acres	3

Number of Housing Units Owned in Meeker

None	51
1 unit	39
2-5 units	9
5 or more units	1

Annual Family Income

Under 1,000.00	3
$ 1,001.00 - $ 4,999.00	14
$ 5,000.00 - $ 7,999.00	19
$ 8,000.00 - $12,999.00	36
$13,000 and over	28

Total Years Lived in Meeker

Under 1 year	7
1 - 5 years	17
6 - 10 years	10
11 - 20 years	11
Over 20 years.	55

If Housing Available to Suit Needs and Budget

Buy a new home	41
Buy an older home	34
Buy a new mobile home and put it on own lot	22
Buy a new mobile home and put in modern mobile home park	2
Move mobile home from existing location to modern mobile home park	12

Registered to Vote

Yes	92
No	8

* When the results were analyzed it was obvious that many of the respondents were confused as to how to fill out the questionnaire. The number of responses varied greatly between questions. For example, under general information, 325 responses were recorded to question one, and 359 to question eleven. Also, when respondents were asked to rate a number of items, the law of diminishing returns was realized. For example, in concerns with planning, question 2 had 351 responses, and question 5 only 240. Therefore, the results of this study should be taken with the ever popular grain of salt.

☆ U. S. GOVERNMENT PRINTING OFFICE 1975 - 678-011/335 Reg. 8

88041582

ER'S CARD

N67 1976 v.7

lorado coal :
onmental

OFFICE	DATE RETURNED

(Continued on reverse)

TD 195 .C58 N67 1976 v.7

Northwest Colorado coal :
draft environmental

SC-653, BLDG. 50
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225-0047

DEMCO

BLM LIBRARY
SC-653, BLDG. 50
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225-0047